

CONTRACTING THE ROAD TO DEVELOPMENT

EARLY IMPACTS OF A RURAL ROADS PROGRAM

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International Conference on Infrastructure Economics and Development
Atria Mercure Conference Center, Toulouse
January 14-15, 2010

Motivation

- Literature has for long associated rural poverty to the lack of adequate infrastructure, in particular that associated to transport (Binswanger, Khandker & Ronsenzweig, 1993; Jacoby, 2000)
- Rural road improvements can help reduce transport costs which in turn lead to:
 - Increased productivity and labor demand in agricultural and non-agricultural activities
 - Facilitated access to basic social services (education, health)
- Still, governments have tended to underinvest in rural transport infrastructure (World Bank, 2005)
- Moreover, rural road programs have focused on building new roads/upgrades, disregarding permanent maintenance (Malmberg, 1998)

Motivation II

- A key problem is the lack of efficient mechanisms to efficiently provide these transport services to rural population
- So, how do we make services work for the poor?
 - Transferring responsibilities to local governments and community participation can indeed increase accountability which in turn lead towards improvements in quality of service provision (World Bank, 2004)
- However, more recent studies have been more cautious:
 - Local capture and corruption can make provision of infrastructure services worse under decentralized mechanisms (Bardhan & Moorkherjee, 2006; Olken, 2007)
 - Need to explore theoretical implications of different contract options and more empirical evidence

Research question

- Can we define a mechanism (contract) that can sustainably improve quality of existing rural roads?
 - Poor rehabilitation and maintenance of rural roads increase travel time, allow for roads to remain blocked for several months
 - Extra money can help, but Local capture and corruption threatens effectiveness
 - Observability of outcome-based contracts may be key
- Does it lead to increased income, human capital investments?
 - People use these roads to go to schools, health centers, sell in larger markets, public programs/providers of ag services find it easier to reach beneficiaries in remote areas, etc
 - Too early for certain effects?
 - Need complementary investments?

Previous studies

- There are many studies that have analyzed impacts of rural roads, but in general, measuring size and distribution of benefits has not been easy, due to lack of adequate data and other methodological issues
- Only recent studies have been able to use more rigorous approaches to evaluate the impact of rural road programs (RRPs) (Khandker, Bakht, Koolwal, 2006 for Bangladesh; Mu and van de Walle, 2007 for Vietnam)
 - Using double-difference estimates based on quasi-experimental designs
 - Analyzing heterogeneity of effects (pro-poor bias)
 - Including effects on human capital investments (education and health)

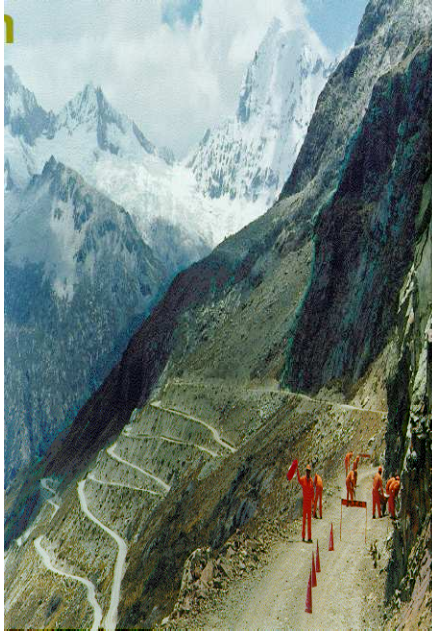
The Peruvian RRP

- Rural roads in Peru were traditionally the responsibility of the central government (MTC)
 - So, when a road was blocked, they sure called the MTC, although response could take a long time
 - But, regular maintenance was nobody's job, so many roads remain in bad quality and users have nobody to complain to
- Decentralization law of 1984 transferred responsibility of roads to regional and local levels
 - Law of municipalities of 1991 confirm rural roads for provincial municipalities
 - However, lack of financial and technical resources limited applications
- Key of the Peruvian RRP intervention is to strengthen participation of local governments and community

The Peruvian RRP

- Intervention is based on contracting the rehabilitation and maintenance of selected unpaved road segments
 - To local firms formed by local residents with funding from the RRP
 - Program also offers technical assistance to local firms and local governments involved
 - Output-based contract, with supervision by local authorities and community participation
- Local governments have crucial participation in selection of treated road segments
 - Departmental office and authorities pick province
 - Provincial office and authorities pick the specific road segment
- Eligible roads include not only motorized roads (MR) but also non-motorized tracks (NMT), based on gender equity approach
 - Intervention does not include upgrades to paved roads (Bangladesh) nor building new roads (Vietnam)
 - Instead, it includes not only road rehabilitation, but also permanent maintenance

Treated roads: Key examples



Motorized roads

Non-motorized tracks



Treated roads: key examples

Maintenance local teams



Road improvements



Characteristics of the study

- I evaluate the impact of the Peruvian RRP, based on a quasi-experiment
 - Interventions on other associated roads are not prohibited. So, we estimate **impacts of differentiated incentive structure associated to contract with local firms**
 - Selection of beneficiary road segments by program and local authorities leads to estimated treatment effects different from average treatment effects (ATE)
 - This study looks at the 2004 round of interventions, only 2 years later (**early effects**)
- Unit of Intervention is the road segment (from village A to village B)

Methodology: Quasi-experimental design

- For each prioritized road segment by the RRP, a control road was selected prior to the intervention, so that:
 - Same road type (motorized, non-motorized)
 - Located in same province, although different district
 - No prioritized by RRP, and without intersections with prioritized segments
- In addition, we look for ex-ante similarities in:
 - Length of road segment
 - hierarchy, population size, altitude of villages involved
 - Access to productive infrastructure and public services

Panel sample distribution, by department

Department	Total programmed	Total completed	
Ancash	239	211	<ul style="list-style-type: none"> ➤ Initial RRP interventions focused poorest departments (13) <ul style="list-style-type: none"> ➤ Exclusively in the Peruvian sierra and selva ➤ Baseline in 2004: 2 457 observations in 387 villages <ul style="list-style-type: none"> ➤ associated to 94 treated segments and 88 control segments ➤ 2 villages per segment if less than 20 kms (3 for longer ones) ➤ 6 hh surveys per village ➤ In 2006, we re-interviewed 81.6% of the households
Apurimac	204	199	
Arequipa	72	70	
Ayacucho	218	115	
Cajamarca	191	172	
Cuzco	301	252	
Huancavelica	218	194	
Huanuco	228	178	
Junin	306	249	
Madre de Dios	60	50	
Pasco	143	94	
Puno	156	144	
San Martín	121	76	
Total	2457	2004	
Rate of response		81.6%	

Pre-treatment differences 2004 cohort

Variables (%)	Control	Treatment	Difference	T-stat
<i>Age</i>				
[0-8]	27.3	28.3	-1.0	-1.10
[9-18]	24.5	24.2	0.3	0.37
[19-35]	23.7	23.5	0.2	0.20
More than 36 years old	24.5	24.0	0.5	0.59
<i>Education (with 3 years or more)</i>				
No level	13.3	13.3	0.0	0.04
Pre - school	8.4	9.0	-0.6	-1.04
Primary	50.0	50.0	0.0	-0.01
Secondary	25.0	24.7	0.3	0.29
Superior	3.3	3.0	0.3	0.92
<i>Household variables</i>				
% of households with access to water	52.6	52.6	0.0	-0.01
Female household head	11.3	10.8	0.5	0.38
Head with indigenous mother tongue	62.6	59.9	2.6	1.26
Per Capita Expenditure (monthly)	87.6	93.0	-5.4	-1.43
Per Capita Income (monthly)	92.7	91.2	1.4	0.28
<i>Poverty</i>				
Extreme	51.0	49.7	1.2	0.57
No extreme	30.7	30.6	0.1	0.04
<i>Village level variables</i>				
Population size	874.7	1023.4	-148.7	-0.76
Altitude	2722.6	2799.0	-76.4	-0.55

Methodology of analysis: DD estimator

- Baseline and follow up surveys were applied
- Program effects are estimated from the double-difference estimator (DD)

$$Y_{ijt} = \beta_0 + \beta_3 \cdot D_t^{AD} \cdot D_j^{TC} + \lambda_t + v_{ij} + \varepsilon_{ijt}$$

- Controlling for time (λ_t) and household (v_{ij}) fixed effects, the DD estimator (β_3) controls for time invariant observables and unobservables differences between treatment and control groups

Summary of results

- RRP interventions improve rural transport
 - Reduce average travel time in treated road segments
 - Very positive perception about the quality of the rehabilitation and maintenance of treated rural roads
- Early effects on household income absent on average. However,
 - positive income effects for MRs in higher altitude villages
 - Effects appear strong when conditioning on key infrastructure (power, communications, local markets)
 - We do not find effects on household tasks, diversification of income sources, either

Summary of results II

- Employment effects are more important for women
 - MRs: non-agricultural waged employment
 - NMTs: agricultural non-waged employment
- Effects on household investments in human capital are important, especially in MRs
 - for school attendance for younger girls (6-12)
 - Protection of health of younger children (0-5)

Direct effects on transport

Dependent variable ^{a/}	At baseline			DD (FE)	
	Treated	Control	Diff		
	(1)	(2)	(3)	(8)	
<i>Motorized tracks</i>					
Roads rehabilitated in past 2 years	0.92	0.73	0.18 (0.14)	-0.03 (0.22)	
Road of reference					
Travel time	101.45	99.55	1.90 (11.26)	-28.07 (16.51)	*
# months road remains blocked	1.97	n.a.	n.a.	0.59 (0.18)	***
<i>Non-Motorized tracks</i>					
Roads rehabilitated in past 2 years	1.14	0.39	0.75 (0.23)	*** -0.44 (0.38)	
Road of reference					
Travel time	172.87	180.34	-7.46 (5.45)	-37.04 (9.55)	***
# months road remains blocked	2.125	n.a.	n.a.	0.64 (0.46)	

Beneficiaries' perception on the RRP work

Variables	Motorized roads			Non-Motorized tracks		
	2004	2006		2004	2006	
<i>Community leaders</i>						
Adequate rehabilitation	62.1	80.6	***	84.1	60.0	**
Adequate maintenance	67.9	75.0		70.5	47.1	**
<i>Households</i>						
Benefits for improvement in transportation	60.1	73.9	***	47.4	65.0	***
Due to RRP	54.1	71.0	***	37.3	60.8	***

Household income, expenditure and poverty: MRs vs. NMTs

Dependent variables	Treated at Baseline	DD (FE)
<i>Motorized road</i>		
Household monthly income	358.31	6.18 (19.63)
Household monthly expenditure	407.012	-2.626 (29.509)
Poverty rate		
Extreme	61.246	-4.914 (3.074)
No extreme	20.036	3.676 (2.849)
Non-poor	18.701	1.238 (2.438)
<i>Non-motorized track</i>		
Household monthly income	322.06	31.86 (32.97)
Household monthly expenditure	372.625	42.897 (47.290)
Poverty rate		
Extreme	62.579	-2.258 (5.883)
No extreme	20.435	-2.631 (5.295)
Non-poor	16.967	4.889 (4.410)

Heterogeneity of income effects

	Motorized roads		Non-motorized tracks	
	Treated at baseline	DD (FE)	Treated at baseline	DD (FE)
Base Model	358.31	6.18 (19.63)	322.06	31.86 (32.97)
Household head's schooling				
Lower	308.40	-8.25 (24.45)	306.99	40.90 (41.13)
Higher	433.57	32.01 (32.93)	344.05	15.60 (55.43)
Village size				
Small	347.00	35.82 (34.42)	312.13	6.37 (52.71)
Medium	357.32	-14.13 (35.57)	298.66	62.09 (66.02)
Large	375.45	47.72 (41.45)	413.73	-79.08 (71.45)
Altitude				
Low	347.40	-34.26 (38.16)	265.88	65.52 (78.36)
Medium	384.28	21.97 (37.65)	368.37	-8.77 (68.86)
High	311.55	78.40 (35.69) **	326.27	2.99 (57.53)

Pre-requisites for income effects

	Motorized roads			Non-motorized tracks	
	Treated at baseline	DD (FE)		Treated at baseline	DD (FE)
Infrastructure					
Electricity					
Without	348.06	-5.59 (27.68)		328.60	-7.03 (50.33)
With	371.88	64.02 (32.20)	**	351.74	8.33 (50.04)
Local markets					
Without	359.95	0.91 (21.75)		343.60	22.59 (36.68)
With	348.25	269.88 (72.38)	***	241.52	-227.67 (142.03)
Public telephone					
Without	355.75	2.56 (28.75)		307.00	13.65 (45.06)
With	362.34	50.53 (30.49)	*	374.77	-31.68 (60.02)
Institutional presence					
Technical Assistance					
Without	355.20	45.17 (26.78)	*	335.18	4.21 (40.17)
With	364.46	-6.42 (33.76)		350.67	-11.37 (77.13)
Credit					
Without	357.02	36.39 (22.52)		334.65	4.34 (37.74)
With	373.50	-62.06 (57.60)		376.17	44.35 (99.14)

Employment (main activity): MRs vs. NMTs

Dependant variables	Treated at	
	Baseline	DD (FE)
<i>Motorized road</i>		
Working days per year	170.929	-4.553 (5.420)
Wage - Agriculture	7.501	3.808 ** (1.702)
Wage - No agriculture	10.044	5.683 ** (2.244)
Non wage - Agriculture	74.869	-0.539 (5.436)
Non wage - No Agriculture	23.776	-2.036 (3.320)
Unpaid family worker - Agriculture	50.991	-8.986 ** (4.026)
Unpaid family worker - No Agriculture	2.754	-2.527 (1.539)
<i>Non-motorized track</i>		
Working days per year	177.461	10.141 (9.781)
Wage - Agriculture	1.996	1.383 (2.457)
Wage - No agriculture	8.976	-4.994 (3.633)
Non wage - Agriculture	92.564	1.584 (10.544)
Non wage - No Agriculture	16.713	-1.373 (4.747)
Unpaid family worker - Agriculture	53.783	16.393 ** (7.511)
Unpaid family worker - No Agriculture	2.470	-2.701 (2.530)

Employment effects by gender

Dependent variable ^{a/}	Base model	Female	Male
<i>Motorized tracks</i>			
Working days per year	-4.55 (5.42)	-9.61 -(7.43)	3.33 (7.33)
Wage - Agriculture	3.81 ** (1.70)	4.06 * -(2.41)	3.53 (2.38)
Wage - No agriculture	5.68 ** (2.24)	3.56 -(3.16)	7.98 ** (3.12)
Non wage - Agriculture	-0.54 (5.44)	2.90 -(6.92)	-3.44 (6.84)
Non wage - No Agriculture	-2.04 (3.32)	-2.91 -(4.72)	-0.73 (4.66)
Unpaid family worker - Agriculture	-8.99 ** (4.03)	-14.45 *** (5.45)	-1.86 (5.38)
Unpaid family worker - No Agriculture	-2.53 (1.54)	-3.14 -(2.18)	-2.00 (2.16)
<i>Non-Motorized tracks</i>			
Working days per year	10.14 (9.78)	29.92 ** (13.29)	-8.73 (13.22)
Wage - Agriculture	1.38 (2.46)	1.09 -(3.47)	1.87 (3.46)
Wage - No agriculture	-4.99 (3.63)	-4.23 (5.10)	-5.66 (5.07)
Non wage - Agriculture	1.58 (10.54)	16.37 -(13.48)	-12.77 (13.41)
Non wage - No Agriculture	-1.37 (4.75)	1.03 -(6.72)	-3.79 (6.69)
Unpaid family worker - Agriculture	16.39 ** (7.51)	20.46 ** (10.24)	12.59 (10.19)
Unpaid family worker - No Agriculture	-2.70 (2.53)	-4.65 -(3.58)	-0.95 (3.56)

School attendance

Dependant variables	Treated at baseline	DD (FE)	
<i>Motorized roads</i>			
Males 6-11 years	95.435	-3.752 (3.082)	
Males 12-18 years	84.153	7.291 (4.276)	*
Females 6-11 years	93.196	6.898 (2.862)	**
Females 12-18 years	80.628	-0.222 (4.156)	
<i>Non-Motorized tracks</i>			
Males 6-11 years	92.936	-2.751 (6.276)	
Males 12-18 years	83.541	-6.706 (7.372)	
Females 6-11 years	89.290	-1.789 (6.592)	
Females 12-18 years	79.579	-8.741 (8.286)	

Morbidity and use of health services

Dependant variables	Treated at baseline	DD (FE)	
<i>Motorized roads</i>			
Sickness and accidents in last 4 weeks			
All household members	38.569	-3.724	**
		(1.434)	
Children 0-5 years	47.757	-8.789	**
		(3.998)	
Attention from a health professional			
All household members	21.441	-2.591	**
		(1.255)	
Children 0-5 years	38.368	-8.078	**
		(3.972)	
<i>Non-Motorized tracks</i>			
Sickness and accidents in last 4 weeks			
All household members	32.806	2.141	
		(2.567)	
Children 0-5 years	46.487	-7.385	
		(7.526)	
Attention from a health professional			
All household members	17.254	2.598	
		(2.120)	
Children 0-5 years	35.768	-12.498	*
		(7.008)	

Access to Social Programs

Dependent variable ^{a/}	Treated at Baseline	DD (FE)
<i>Motorized roads</i>		
Social Programs		
Food	73.208	4.388 (2.695)
Education	63.396	4.067 (2.595)
Health	54.843	0.869 (2.852)
ECD (hh w/children < 6)	95.560	6.092 (2.093)
<i>Non-Motorized tracks</i>		
Social Programs		
Food	68.619	-2.092 (4.788)
Education	69.874	-7.531 (4.875)
Health	44.351	4.603 (5.118)
ECD (hh w/children < 6)	94.776	-6.094 (3.904)

Discussion

- Contracting rehabilitation and maintenance can work to improve transitability of rural roads
 - Provided incentives and enforcement are set right to promote preventing activities and timely rehabilitation and maintenance
 - Possible key element: including regular maintenance allows for output-based contracts (community supervision can be based on observables)
 - And that may have helped the program resist corruption threats (Olken, 2007)

Discussion

- Improved roads generate some early income (not for all, and with some key conditions) and overall welfare of the associated population
 - Even without including building new roads, upgrading to paved roads
 - Even in poorer areas where the presence of the state is otherwise rather slim, and poverty high
 - Employment effects differentiated by gender are important, and lead to a justification to include NMTs,
 - Still, further analysis is required on their implications for gender equity
- Improvements in human capital accumulation are very important, especially early
 - for school attendance for younger girls (6-12)
 - Protection of health of younger children (0-5)

Discussion

- Impacts clearly differentiated between motorized roads (MR) and non-motorized tracks (NMT)
- MRs and NMTs play different roles in the “road network”?
 - MRs improve connection to larger cities, improving access to schools and health centers, also to non-agricultural employment opportunities
 - NMTs improves connection between parcels and residences; to sources of water/wood
 - Allows household members, especially women, work more in the family plots without sacrificing school attendance and household chores



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