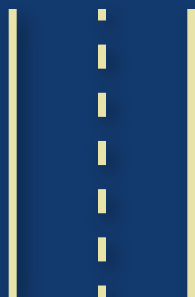


ESTIMATING THE IMPACT OF ACCESS TO
**INFRASTRUCTURE AND
EXTENSION SERVICES**

IN Rural Nepal

Andrew Dillon,
Manohar Sharma, and
Xiaobo Zhang



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Andrew Dillon, Manohar Sharma,
and Xiaobo Zhang

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Foreword

The allocation of public expenditures in rural areas is of paramount importance if rural poverty reduction and agricultural growth are key objectives in a country's development strategy. Nepal is a good example of a country where rural development expenditures are formally prioritized within the budgetary planning process, but development strategy must be combined with impact assessment to determine the effectiveness of different types of expenditures.

The Ninth Five-Year Plan provided policymakers with a coherent development strategy that emphasized regional interconnectivity to unlock the agroecological diversity of the country. Despite this development strategy, policymakers are often faced with difficult choices over the ranking of public expenditures or deciding which expenditures are paying off in terms of poverty reduction and growth. This research monograph provides evidence about whether access to rural roads, irrigation infrastructure, and extension services had a significant impact on household welfare over the period of the Ninth Five-Year Plan.

However, evaluating the impact of public investment is limited by methodological challenges. Each of the commonly used econometric techniques has its advantages and limitations. This research uses diverse identification strategies to reduce the risk of using a narrower set of results driven primarily by a particular methodology. IFPRI research shows that the effect of rural roads is robust across two different econometric strategies, while the effect of irrigation and extension services on household welfare is less robust. Access to rural roads improves households' welfare as measured by land values, consumption growth, poverty reduction, and agricultural income growth. The research also shows statistically significant impacts of irrigation using a hedonic model, while an alternative panel data approach did not yield significant estimates of the impact of access to irrigation or extension services. These results identify both areas in which further expenditure allocations should be made and areas in which future research is needed to better understand how the effectiveness of certain rural investments can be improved.

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Director General, International Food Policy Research Institute

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Acronyms and Abbreviations

APP	Agricultural Perspective Plan
CBS	Central Bureau of Statistics
GMM	generalized method of moments
IFPRI	International Food Policy Research Institute
INSEC	Informal Sector Service Centre
ISIC	International Standard Industry Classification
MOF	Ministry of Finance
NLSS 1	Nepal Living Standards Survey 1
NLSS 2	Nepal Living Standards Survey 2
NPC	National Planning Commission
NPR	Nepal rupees

Summary

Because Nepal has a largely rural society, most people in the country still depend on agriculture as their major livelihood strategy. However, in part due to the domestic conflict there, agricultural performance was disappointing during past decades. With the peace process in place, it has become important to consider ways to stimulate agricultural growth and poverty reduction by making prudent public investments. This research monograph reviews government spending patterns and the political process of budgeting under Nepal's Ninth Five-Year Plan. Using different data sources and methodologies, we examine the impact of certain public rural investments. The use of diverse data sources and methods has yielded a range of estimates of the effect of access to agricultural public investments and reduced the risk of using a narrower set of results driven primarily by a particular data source or methodology. The convergence of results across methods and data sources contributes to the confidence with which we can draw conclusions.

Overall, agricultural growth did not meet the expectations set forth in the Ninth Five-Year Plan over the period covered by our analysis. Large gains in poverty reduction have been largely driven by rural-to-urban migration and remittances. However, the underlying approach outlined in the Ninth Five-Year Plan, to reduce poverty by emphasizing the growth potential of rural farmers and the comparative advantages of Nepal's unique agroecological environment, continues to have the potential to significantly improve rural welfare. The approach that seems most consistent with our results would be to increase the connectivity of these areas with rural roads, better integrating farmers with markets and increasing their productive capacity by improving their access to irrigation and high-quality extension advice.

Our most robust empirical results illustrate the impact of rural roads. Using information based on different methodologies, we show that rural roads improve households' welfare as measured by land values, consumption growth, poverty reduction, or agricultural income growth. We also show statistically significant impacts of irrigation using a hedonic model with two cross-sections of data. Our hedonic estimates of the effect of extension on land values in 2003/04 found that extension has a significant impact, while our estimates for 1995/96 suggest a positive yet statistically insignificant effect. However, the alternative panel approach did not yield significant estimates of the impact of access to irrigation or extension services.

Introduction

Recent gains in poverty reduction in Nepal have not been driven primarily by increased agricultural growth or productivity increases in the agricultural sector. The ongoing civil conflict has disrupted the rural economy, resulting in significant rural-to-urban migration. Government spending has been diverted to address alternative objectives, namely defense and debt service. Because of the potential of the agricultural sector to contribute to poverty reduction, and with internal conflicts abating recently, it is critically important to evaluate the portfolios of public investment in the agricultural and rural sectors so as to better allocate the limited financial resources to achieve higher agricultural growth and poverty reduction in rural farm areas. Despite the importance of this issue, there have been few rigorous reviews of publicly funded infrastructure and extension services in Nepal.¹ The purpose of such research is to assess the impact of access to different types of infrastructure and services. Although Nepal has undergone a major political change since 2007, since the country became a republic, lessons learned from the earlier period have continued to be relevant for the future because the basic public expenditure management system, at both the planning and the operational levels, remains intact. Hence, even in the current context, this study is expected to make a significant contribution to assisting policymakers in evaluating the different policy options available in the light of their impact on development.

Significant econometric challenges confront the estimation of the impact of rural public investments at the aggregate level over a long period using the approach of randomized experiments as advocated by the recent literature (Duflo 2006). Therefore, in practice, most studies use only data available from secondary sources and estimate only a single set of impact estimates for different types of public infrastructure and services based on one data

¹ The World Bank conducted a qualitative assessment in 2000. This work, funded by the U.K. Department for International Development, was originally intended to be a quantitative extension of this previous work.

source. However, given the lack of clarity of the underlying mechanism of public investment decisions and attendant data problems in estimating the impact of public investments, the approach followed in this research monograph is to analyze the sensitivity of these estimates based on alternative data sources and methodological approaches. We point out the limitations of different methodologies but underscore that all currently available methodologies for estimating the impact of publicly funded rural infrastructure and services have some defects. The use of cross-sectional and panel data sources yields a range of estimates of the impact of access to infrastructure and services and reduces the risk of using a narrower set of results driven primarily by data source or methodology. The convergence of results across methods and data sources contributes to the confidence with which we can draw conclusions. These results are interpreted in a historical context and in consultation with national stakeholders, which also increases our confidence in these results.

The monograph is arranged as follows. In Chapter 2, trends in the agricultural sector are assessed. Chapter 3 reviews agricultural public expenditure and its priority relative to other spending. Based on these reviews, we then discuss our econometric identification strategy and estimate the impact of publicly funded rural infrastructure and extension services. Chapter 3 also discusses the policymaking process in Nepal in light of the current political situation and the impact of conflict on public expenditure allocation. Apart from the impact of the political process on the allocation of public expenditure to the agricultural sector, the implementation of programs funded has been disrupted because of ongoing conflict. The conflict has affected access to infrastructure and extension services because of the increased difficulty to government workers of implementing projects in conflict zones because of either the unwillingness of government staff to be posted in conflict areas or their inability to travel to certain parts of the district because of threats of violence, as well as the delay in the transfer of funds to district officials from the central government. Chapter 4 lays out the analytical framework to evaluate the impact of access to agricultural extension, irrigation, and rural roads using a hedonic approach. We also present the results of the hedonic approach in this chapter. In Chapter 5, the results of a panel data approach are presented after detailing the econometric approach. Overall conclusions are presented in Chapter 6.

Policy Setting, Goals, and General Economic Outcomes in the Agricultural and Rural Sector during 1997–2002

The period for which we review policymaking in the rural and agricultural sector, 1997–2002, fell within Nepal’s Ninth Five-Year Plan. To that extent, annual budgetary allocations were, at least in principle, required to maintain some kind of alignment with the basic objectives and strategy of the Ninth Plan. In practice, Maoist insurgency, which escalated sharply, especially after the year 2000, derailed much of the planning process, resulting in sharply increased claims for security-related activities against the national treasury. It is nevertheless instructive to provide some background information on the Ninth Plan and the long-term Agricultural Perspective Plan to which it was anchored. This is because the ultimate impact of rural public investment during 1997–2002 must, sensibly, be evaluated against the goals set in the Ninth Plan and the longer-term Agricultural Perspective Plan. A general description of the broad outcomes over the period covered by the plan is included because it provides the context in which impact estimates can be verified and evaluated.

Policy Setting and Goals

The key objective of the Ninth Plan was to reduce the national poverty headcount from 42 percent (as measured in 1996) to 32 percent by the end of the period covered by the plan. The development of the agricultural sector was perceived to be the most important means of achieving this objective, and the plan document indicated that “the agricultural sector will be given a lead role to play in poverty alleviation,” recognizing that this sector was the “backbone of the economic development” and that the “majority of the people depend on it to earn their livelihood” (Nepal, NPC 1995). The strategy explicitly adopted in the plan to develop the agricultural sector was the long-term Agricultural Perspective Plan (APP), which had a strong regional focus.

The APP recognized that although there was no scope for increasing land area to increase agricultural production, the numerous agroecological zones provided a basis for comprehensive agricultural development based on linking different regions of the country through markets and infrastructure and exploiting production and trade among them based on comparative advantage. In particular, the intensification of foodgrain production was emphasized for the Terai Region, which was expected to boost the demand for high-value agricultural crops produced in the hill and mountain regions. The main objectives of the APP were to accelerate the growth of agricultural income from 0.5 to 3.0 percent, to ensure food security by increasing per capita food availability from 270 to 426 kilograms, and to reduce the regional imbalance in agricultural development.

Targeted growth rates for key agricultural subsectors in the Ninth Plan are given in Table 2.1. The key programs in which these goals were to be achieved were the following:

- Cropping intensity and productivity enhancement programs to increase crop yields in areas served by irrigation and road links
- Programs for the development and promotion of high-value agricultural commodities, especially in areas served by roads and small irrigation projects
- Programs for the development of the livestock sector to increase the productivity and production of major livestock products such as milk, meat, and eggs
- Programs for the promotion of agricultural business to provide the necessary impetus to commercialize the agriculture sector
- Irrigation facilities expansion and utilization programs with a focus on tube-well irrigation in the Terai and on small-scale irrigation projects in both Terai and the mountainous regions

Table 2.1 Major agricultural growth targets of Nepal's Ninth Plan, 1997-2002

Subsector	Targeted annual growth rate
Foodgrains	5.18
Cash crops	6.50
Pulses	6.04
Horticulture	3.54
Livestock	6.00
Fisheries	8.76
Agriculture sector as whole	5.33

Source: ANZDEC Limited (2002).

- Programs to ensure a continuous supply of fertilizer through the involvement of the private sector in both the procurement and the distribution of fertilizer
- Programs to increase the flow of agricultural credit for the Agricultural Development Bank
- Programs to develop agricultural roads and electrification
- Agricultural research and extension programs aimed at enhancing productivity in crop as well as livestock production

Overall Economic Performance during the Period Covered by the Ninth Plan

Despite the objectives of the Ninth Five-Year Plan, growth in the agricultural sector showed a mixed performance. The agricultural sector grew by 3.36 percent from 1995 to 2005 compared to 4.04 percent for the nonagricultural sector over the same period (Table 2.2). The agricultural growth rate fluctuated considerably; it was negative (-0.5 percent) in the first part of 1990s and positive (0.7 percent) in the second part of the 1990s (ANZDEC Limited 2002).

Poverty declined sharply in Nepal between 1995 and 2003 (Table 2.3), but the decline was quite uneven between rural and urban areas. Poverty reduction, measured by the headcount poverty rate, declined by 26 percent for Nepal as a whole over the eight-year period. However, declines in urban poverty (56 percent) overshadowed declines in rural poverty (20 percent). Inequality measured by the poverty gap also decreased by 36 percent. Declines in the urban sector (67 percent) likewise surpassed declines in inequality in the rural sector (30 percent).

When poverty rates are disaggregated by the sector of employment of the household head, as in Table 2.4, the declines in headcount poverty rates for both the self-employed (24 percent) and wage earners (4 percent) in agriculture can be seen to have been the lowest within these subgroups relative to self-employed traders (66 percent decline) or wage-earning professionals (74 percent decline). This table illustrates that despite large decreases in poverty, these decreases were not equally distributed across Nepalese society. Specifically, over the eight years in question, the lowest amount of poverty reduction occurred in the agricultural sector relative to other sectors of the economy. Table 2.5 illustrates the importance of landholdings to poverty status and the changes in poverty rates based on a household's initial landholdings between 1995 and 2003. For households that held less than 0.2 hectares, the poverty headcount ratio was the highest (39 percent) compared to those in the other landholding categories. Poverty decreased by 17 percent for this group compared to 15 percent for the group of households who held 0.2-1.0

Table 2.2 Annual growth rates of GDP in Nepal, by International Standard Industry Classification (ISIC) division, 1995/96-2004/05 (percent)

ISIC division	1995/96	1996/97	1997/98	1998/99	1999/2000	2000/01	2001/02	2002/03	2003/04 ^a	2004/05 ^b
Agriculture, fisheries, and forestry	3.81	4.36	0.85	2.84	4.89	5.48	2.23	2.5	3.86	2.8
Mining and quarrying	13.0	6.79	1.26	3.73	4.56	4.49	1.55	1.93	0.53	0.71
Manufacturing	9.04	7.05	3.42	5.29	7.2	3.76	-9.97	1.98	1.73	2.75
Electricity, gas, and water	19.28	1.78	-4.13	5.67	14.34	17.44	10.01	23.12	2.51	7.98
Construction	7.1	6.63	2.2	6.8	9.6	0.87	1.12	1.79	0.19	-2.43
Trade, restaurants, and hotels	4.51	4.07	5.76	3.89	6.76	1.52	-10.09	3.31	6.03	-3.02
Transport, communication, and storage	5.46	7.74	8.08	6.8	7.02	6.19	1.63	4.3	5.26	5.37
Finance and real estate	7.61	4.71	5.87	5	5.08	1.72	3.31	3.28	2.13	2.92
Community and social services	6.16	3.61	7.62	6.62	3.97	13.25	1.85	3.1	2.87	3.91
Agriculture	3.81	4.36	0.85	2.84	4.89	5.48	2.23	2.5	3.86	2.8
Nonagriculture	6.99	5.43	4.98	5.63	6.83	4.5	-1.91	3.5	2.87	1.56

Source: Nepal, CBS (2003).

^aRevised estimates.

^bPreliminary estimates.

Table 2.3 Poverty in Nepal, 1995-96 and 2003-04 (percent)

Region	Headcount poverty rate			Poverty gap ($\times 100$)			Squared poverty gap ($\times 100$)		
	1995-96	2003-04	Percentage change	1995-96	2003-04	Percentage change	1995-96	2003-04	Percentage change
All Nepal	41.8	30.9	-26	11.8	7.5	-36	4.7	2.7	-42
Urban	21.6	9.6	-56	6.6	2.2	-67	2.7	0.7	-13
Rural	43.3	34.6	-20	12.1	8.5	-30	4.8	3.1	-37

Source: World Bank (2006, 6).

Table 2.4 Poverty in Nepal, by employment sector of the household head, 1995-96 and 2003-04 (percent)

Employment sector	Headcount poverty rate			Distribution of the poor			Distribution of the population		
	1995-96	2003-04	Percentage change	1995-96	2003-04	Percentage change	1995-96	2003-04	Percentage change
Self-employed									
Agriculture	43.1	32.9	-24	60.7	66.9	10	58.8	62.7	7
Manufacturing	41.4	31.2	-25	3.4	4.5	32	3.4	4.4	29
Trade	32.2	11.1	-66	4.3	1.6	-62	5.6	4.5	-19
Services	25.3	14.4	-43	1.0	1.5	53	1.6	3.2	99
Wage earner									
Agriculture	55.9	53.8	-4	15.7	10.9	-31	11.7	6.2	-47
Professional	8.3	2.1	-74	0.4	0.2	-53	2.2	2.9	35
Other	39.7	28.8	-28	10.6	10	-6	11.1	10.7	-4
Unemployed	9.5	2.9	-69	0.1	0	-68	0.3	0.2	-23
Nonactive	30.5	26.9	-12	3.9	4.4	14	5.3	5.1	-4
Total	41.8	30.8	-26	100.0	100.0		100.0	100.0	

Source: World Bank (2006, 13).

Table 2.5 Poverty measurement in Nepal, by landownership (rural areas only), 1995-96 and 2003-04 (percent)

Landholdings (hectares)	Poverty headcount rate			Distribution of the poor			Distribution of the population		
	1995-96	2003-04	Percentage change	1995-96	2003-04	Percentage change	1995-96	2003-04	Percentage change
<0.2	48	39	-17	23	25	10	21	22	7
0.2-1.0	45	38	-15	44	51	17	42	47	11
1.0-2.0	39	27	-29	19	16	-14	21	20	-3
>2.0	39	24	-39	15	8	-49	16	11	-32
Total	43	35	-20	100	100	0	100	100	0

Source: World Bank (2006, 16).

Table 2.6 Sources of household income in Nepal, 1995-96 and 2003-04 (average per capita income in real 1995-96 rupees)

Source of income	Urban			Rural			Nepal		
	1995-96	2003-04	Percentage change	1995-96	2003-04	Percentage change	1995-96	2003-04	Percentage change
Farm income	1,446	1,433	-1	3,246	3,252	0	3,122	2,983	-4
Agricultural wage income	151	121	-20	710	621	-13	672	547	-19
Nonagricultural wage income	3,543	5,234	48	829	1,298	57	1,016	1,880	85
Nonagricultural enterprises	3,688	4,778	30	649	917	41	859	1,489	73
Property income	300	493	64	36	44	22	55	111	103
Remittances income	499	1,944	290	548	1,306	139	544	1,401	157
Housing income	2,935	4,687	60	596	690	16	757	1,282	69
Other income	553	910	64	138	355	158	167	437	163
Total	13,115	19,601	49	6,753	8,484	26	7,191	10,129	41

Source: World Bank (2006, 46).

hectares of land. However, households with access to more than 2.0 hectares of land had poverty headcount decreases of 39 percent over the same time period.

Decreases in the poverty rates were accompanied by real increases in remittance receipts and nonagricultural wage income in both rural and urban areas. Between 1995 and 2003, migrant remittances increased by a massive 290 percent in urban areas and 139 percent in rural areas (Table 2.6). Non-agricultural wage income also increased in real terms, by 48 percent in urban areas and 57 percent in rural areas. In urban areas, housing income also increased by 60 percent. In striking contrast to increases in remittances and nonagricultural wage income, agricultural wage income declined over the same time period. Urban areas saw declines of 20 percent in agricultural wage income, while rural areas exhibited a 13 percent decline. Table 2.6 lists the average daily wages in the two periods. The table illustrates that in urban areas the wages of skilled workers significantly increased, while unskilled laborers saw their wages decreasing. This was perhaps due to the massive migration of unskilled laborers from rural areas to cities as a result of domestic conflict.

These descriptive statistics suggest that although poverty has been decreasing in Nepal, these changes have not been driven primarily by increases in agricultural income or by agricultural sector growth. Migration has intensified over the past decade, and this has been related to the Maoist conflict. With more people leaving the rural areas, a decreasing share of wage employment and a rising share of self-employment in agriculture have been observed. However, the agricultural sector has had a mediocre performance. Given that most people still live in rural areas and rely on agriculture as the major source of their livelihood, it is important to determine appropriate sets of rural public investments to boost agricultural growth and reverse the trend of declining farming profit. Although poverty reduction has been impressive in Nepal since 1996, this reduction in poverty has not been driven by the agricultural sector as outlined in the Ninth Five-Year Plan. In the following chapters we review the allocation of public resources to the agricultural sector for investments in agriculture, rural roads, and irrigation technology. Then we estimate the impact of access to different types of infrastructure and services to provide recommendations as to the most efficient policy choices to offset rural poverty.

Public Expenditures: Trends and Composition during 1999–2003

This chapter reviews the patterns of public expenditures in various sectors with a particular focus on the agricultural and rural sectors. In addition to reviewing actual expenditures, we provide a brief overview of the budgetary process used to allocate a broad portfolio of funds to differing objectives, including promotion of the agricultural sector. A key objective of the chapter is to examine patterns in the geographic distribution of public expenditures, an important policy issue in Nepal.

The Budgetary Planning and Implementation Process, 1999–2003

The budgetary process in place during the review period was as prescribed by the Constitution of Nepal of 1990, then in effect, and the Financial Administration Act of 1998. Under this system, the Ministry of Finance (MOF) of the Government of Nepal submitted budget estimates for the upcoming fiscal year before the joint session of the parliament. Key agencies involved in the budgetary process were the MOF, the National Planning Commission (NPC), the line ministries, and the departments and projects functioning under each of these ministries. As indicated before, the budgetary process today remains the same as before; the only difference is that the budget is now submitted to Nepal's Constituent Assembly for approval rather than to the parliament, which no longer exists.

The national budget is made up of a "regular" and a "development" budget. The regular budget includes all expenditures of a recurrent nature (for example, administrative and security expenses), while the development budget includes all projects and programs related to production or output. Further, although the MOF plays a leading role in preparing the regular budget, the NPC takes the lead in finalizing the development budget. However, the process by which each budget is formulated and the funds appropriated and spent is guided by the Financial Administrative Act of 1998. This act requires each government agency to formulate a budget for the forthcoming fiscal

year based on an indicative budget envelope and guidelines provided by the MOF or the NPC.

In the case of the regular budget, the annual budgetary process starts with the MOF releasing the indicative budget ceiling and working guidelines for budget formulation for each of the line ministries. This takes place in January of each year, about six months ahead of the start of the next fiscal year in July. Each line ministry then forwards the guidelines and the indicative budget envelope, together with its own set of directives, to all agencies functioning under it, either at the district level or at the central level. Each of these agencies formulates its respective budget using these guidelines and sends it back to the concerned ministry, where it is further vetted, consolidated with the other agency budgets, and forwarded to the MOF for finalization. Once the MOF receives budgets from all line ministries, interministerial meetings are held to further vet and finalize the national regular budget.

The formulation of the development budget is done in a similar fashion, except that the initial budget envelope is formulated and the final vetting is done by the NPC in close consultation with the MOF. Once the regular and development budgets are finalized, they are submitted to the ministerial cabinet for approval, then presented to the Constituent Assembly (formerly to the national parliament) in the form of a budget speech by the minister of finance. Once these budgets are approved, funds are remitted from the central treasury to the concerned agencies through commercial banks, and central ministries authorize agency heads to make the expenditures approved in the budget documents. Finally, all government agencies are required to submit progress reports on budget lines released, funds expended, and targets achieved to the MOF for evaluation.

Although the administrative process for budget formulation, release, and monitoring is fairly well spelled out on paper, this did not necessarily lead to the proper alignment of the annual budgets with the longer-term five-year plans. This was because, in operational terms, the budgetary process and the management of public expenditure during the review period remained a “black box” to a large extent, and overall economic growth, including that of agriculture, remained below targets. The public expenditure review conducted by the World Bank in 2000 (World Bank 2000) provides an excellent critique of public expenditure management in Nepal and attributes the general ineffectiveness of public spending to serious deficiencies in the budget planning, resource allocation, and expenditure management processes. The escalation of the Maoist insurgency and the sharp increase in security-related expenditures toward the end of the review period further derailed public spending.

Review of Key Expenditure Patterns

The objective of this section is to provide a descriptive account of the trends and geographic incidence of various components of government expenditures in the period 1999-2002. This is primarily to allow us to discern broad trends and also to assist us in interpreting impact estimates made later in the monograph.

Key Expenditure Categories

The top 20 expenditure categories over 1999-2003 (Table 3.1) reveal the policy priorities of the Government of Nepal. Education ranked the highest in government priority and was allocated 15.21 percent of the total expenditure. If loan payments are disaggregated into internal and external debts, they are seen to have been the second and third priorities of public expenditures, respectively. In the aggregate, loan payments were the single largest budgetary obligation, representing more than 16 percent of government expenditure over the period. Spending on debt service was four times as great as the expenditure on irrigation. Of the public expenditures that we consider in our analysis, road transportation ranked highest, at 22.95 billion rupees, or 5.74 percent of expenditure between 1999 and 2003. Irrigation and agriculture were the 11th- and 13th-ranked priorities, respectively, representing 3.82 percent and 2.85 percent of the allocated expenditure. Figure 3.1 presents the average population by district over the period 1999-2003, which provides an important benchmark for evaluating public investment across districts. We disaggregate spending in per capita terms later.

The inequality among the priorities of public expenditures is striking. If the defense and police sectors are aggregated into an overarching public security category, loan payments, public security, education, and miscellaneous spending are seen to have accounted for over 50 percent of the government's spending. These expenditures were higher in part due to Nepal's protracted civil war. The large share of expenditures on public security also implies a new opportunity for Nepal: with peace in place, the government may be able to cut the defense spending and use it for more productive purposes.

Figure 3.2 shows the distribution of cumulative total public expenditure for the period 1999-2003 by district in Nepal in per capita terms. Allocation of public expenditures across districts in Nepal was by no means uniform. Per capita cumulative expenditures during 1999-2003 were actually the lowest in the Terai districts, which are thickly populated, but especially high in the western hill and mountain districts, where population density is the thinnest. Kathmandu District was the recipient of the most expenditure in per capita terms. However, this expenditure has been somewhat overestimated. This is because in a number of cases allocations ultimately destined for other

Table 3.1 Top 20 public expenditures in Nepal, by sector, 1999-2003

Rank	Sector	Total by sector (billions of rupees)	Share of total (percent)
1	Education	60,800	15.21
2	External loan payment	33,510	8.39
3	Internal loan payment	32,590	8.16
4	Miscellaneous	32,500	8.13
5	Defense	29,060	7.27
6	Police	27,030	6.76
7	Electricity	25,470	6.37
8	Road transportation	22,950	5.74
9	Local development	21,870	5.47
10	Health	18,450	4.62
11	Irrigation	15,250	3.82
12	Drinking water	11,510	2.88
13	Agriculture	11,400	2.85
14	General administration	10,420	2.61
15	Forests	7,690	1.92
16	Communications	6,774	1.70
17	Constitutional bodies	4,110	1.03
18	Other social	4,046	1.01
19	Industry	3,892	0.97
20	Land reform and survey	2,961	0.74
Total		399,629	95.65

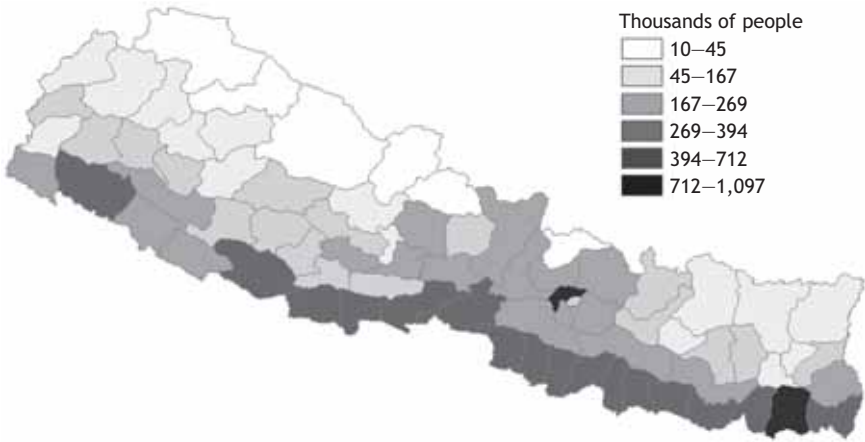
Source: Authors' calculations from public expenditures data (World Bank 2007).

Note: The top 20 public expenditures represent 95.65 percent of total expenditures over the period 1999-2003.

districts are shown as expenditures incurred in Kathmandu simply because the first-stage transfer of funds from the treasury was to an entity that was located in Kathmandu.

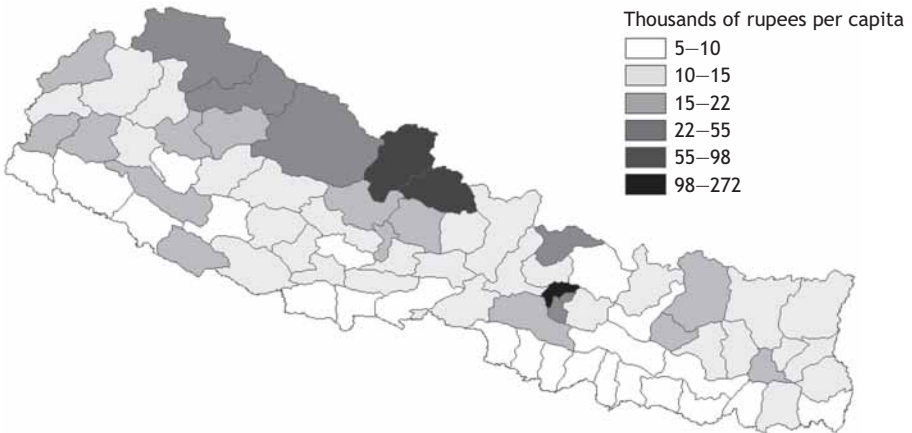
The relative weight of different sectors in total expenditure is further described in Table 3.2. In real terms, total per capita public expenditure in Nepal, in 1995 Nepal rupees (NPR), increased from NPR 3,971 in 1999 to NPR 5,606 in 2003. With respect to the financing of public expenditures, we see that although the proportion financed by internal revenue of the Government of Nepal as well as that financed by foreign grants increased over the period, the proportion of public expenditures financed by foreign grants fell by almost half. In the case of the per capita public expenditure on agriculture, we find that although this did increase, from NPR 132 in 1999 to NPR 171 in 2001, it fell back to NPR 129 in 2003. Over the period, about two-thirds of the expenditure was financed by internal revenues and about a quarter by foreign loans. The contribution of foreign grants increased from about 4 percent in 1999 to 9 percent in 2003. The total expenditures on irrigation, on the other hand, fell over the period, from NPR 195 in 1999 to NPR 159 in 2003, which is perhaps a reflection of the decreasing expenditures on the

Figure 3.1 Average population of Nepal, by district, 1999-2003



Source: Authors' calculations from census data (Nepal, CBS 2002).

Figure 3.2 Total real expenditure per capita in Nepal, 1999-2003



Source: Authors' calculations from public expenditures data (World Bank 2007).

Note: Amounts are in 1995 rupees.

Table 3.2 Real per capita expenditure in Nepal, by source, by sector, 1999-2003 (1995 rupees)

Year	Source	Sector										Total
		Agriculture	Defense	Education	External loan	Forestry	Health	Irrigation	Police	Roads	Other	
1999	Government of Nepal	81	207	446	311	67	143	66	199	122	1,274	2,915
	Foreign grant	5	0	74	0	10	35	13	0	107	100	344
2000	Foreign loan	46	0	42	0	2	30	116	0	42	435	712
	Government of Nepal	103	230	559	366	73	175	78	316	138	1,660	3,698
	Foreign grant	2	0	85	0	6	30	21	0	124	146	414
	Foreign loan	45	0	34	0	2	9	153	0	50	448	739
2001	Government of Nepal	112	355	690	387	88	213	69	372	154	1,543	3,983
	Foreign grant	18	0	99	0	14	23	12	0	107	139	412
2002	Foreign loan	41	0	17	0	0	0	118	0	38	264	478
	Government of Nepal	88	453	704	448	84	188	71	391	92	1,657	4,175
	Foreign grant	9	0	87	0	18	36	15	0	141	375	681
	Foreign loan	27	0	33	0	1	2	64	0	24	132	284
2003	Government of Nepal	86	534	759	487	94	219	69	401	90	1,673	4,411
	Foreign grant	12	0	100	0	19	32	26	0	124	395	709
Total	Foreign loan	31	0	55	0	1	1	64	0	74	260	486
	Government of Nepal	470	1,779	3,158	1,999	406	938	353	1,679	596	7,807	19,182
	Foreign grant	46	0	445	0	67	156	87	0	603	1,155	2,560
	Foreign loan	190	0	181	0	6	42	515	0	228	1,539	2,699

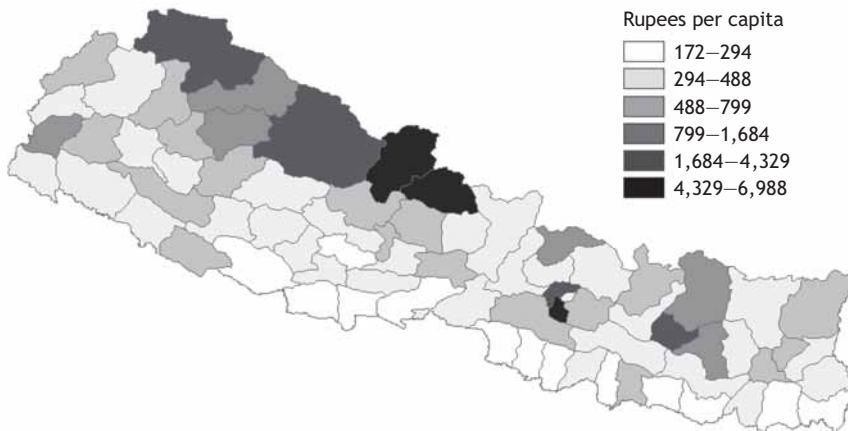
Source: Authors' calculations from World Bank public expenditures data (World Bank 2007).

construction of new infrastructure, given the growing insurgency during the period. However, the important role of foreign loans in financing irrigation is noted. During 1991–2001, about 60 percent of public expenditures in irrigation were financed through loans. These loans, however, dropped heavily in 2002–03 and led to the fall in total expenditures, even though financing from government revenue remained steady over the period. Total expenditures on roads held fairly steady over the period. As in the case of irrigation, foreign financing plays an important role, but the foreign grant component was much higher than in the irrigation sector, accounting for about 40 percent of the expenditure.

Figure 3.3 shows the geographic distribution of cumulative agricultural expenditures in per capita terms. Like total public expenditures, total agricultural expenditures are generally higher in the hill and mountain districts. It is noted that per capita agricultural expenditures were the highest in Manang and Mustang districts in the western mountain region and also in Kathmandu in the central region. In fact, per capita expenditures were generally higher in the western mountainous districts of Humla, Mugu, and Dolpa than in most of the districts in the Terai belt.

Figure 3.4 illustrates the distribution of cumulative irrigation expenditures in Nepal in per capita terms. Per capita expenditures in the western mountain and hill districts were particularly high and comparable to those in the more populated Terai districts. Still, the relatively low per capita expenditures in the western middle hills and indeed in most non-Terai districts in the east are

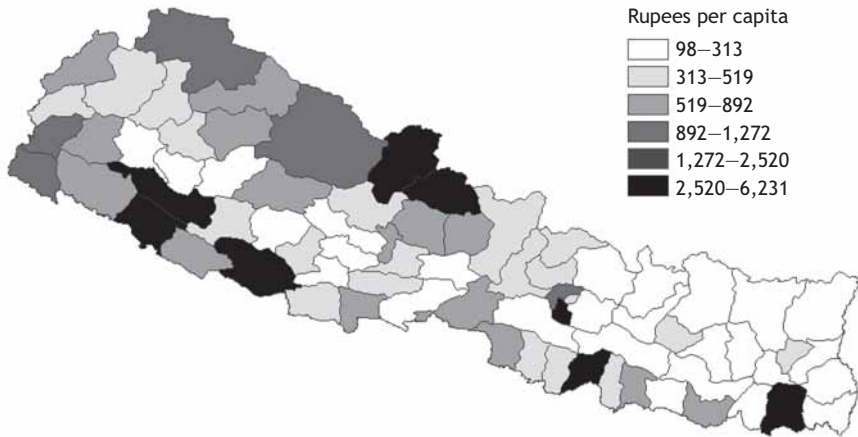
Figure 3.3 Agriculture real expenditure per capita in Nepal, 1999–2003



Source: Authors' calculations from public expenditures data (World Bank 2007).

Note: Amounts are in 1995 rupees.

Figure 3.4 Irrigation real expenditure per capita in Nepal, 1999–2003



Source: Authors' calculations from public expenditures data (World Bank 2007).

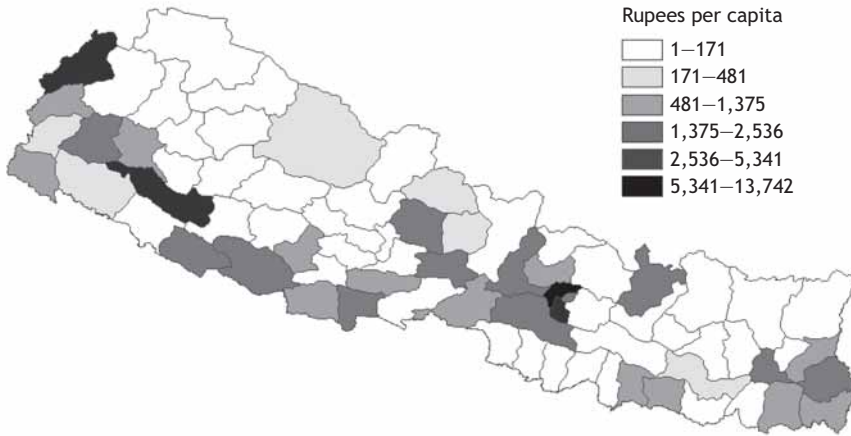
Note: Amounts are in 1995 rupees.

noted. This distribution of irrigation expenditures reflects the reality that the greatest irrigation potential lies mostly in the flat lands of the Terai and not in the difficult terrains of the hills and mountains where, at best, there is a potential only for much smaller and fewer irrigation schemes.

The last type of public expenditure that we investigate is rural roads. Rural roads are essential to reducing travel time to markets and reducing transport costs, which facilitates market integration. Figure 3.5 provides a snapshot of cumulative per capita public expenditures on roads in Nepal between 1999 and 2003. In general, road construction has been extremely limited in the hill and mountain regions of Nepal due to physical constraints of road construction. Figure 3.5 reflects this by illustrating that larger expenditures were more concentrated in the southern parts of the country and also in the central hills. As is the case of agricultural expenditures, the largest amount of expenditure on roads was incurred in the Kathmandu Valley, especially in Kathmandu District itself, with the exceptions of Dolpa and Manang districts in the mountains.

These trends in public expenditures have been coupled with changes in access to government services. Tables 3.3, 3.4, and 3.5 illustrate changes in access to public infrastructure and extension services between 1995–96 and 2003–04. Access time to facilities generally improved, even across the expenditure quintiles, as shown in Table 3.3. One notable exception is the disparity in improvements in the second through the fourth expenditure quintiles relative to the large increases in both the lowest and the highest

Figure 3.5 Roads real expenditure per capita in Nepal, 1999-2003



Source: Authors' calculations from public expenditures data (World Bank 2007).

Note: Amounts are in 1995 rupees.

Table 3.3 Access to selected facilities in Nepal, by expenditure quintile, 2003-04, and improvements since 1995-96

Quintile	Travel time in 2003-04 (mean hours)				Improvements since 1995-96 (percent)			
	School	Health center	Paved road	Market center	School	Health center	Paved road	Market center
Lowest	0.38	1.07	5.59	3.64	34	32	23	32
Second	0.3	0.88	5.5	2.72	17	38	5	17
Third	0.3	0.77	4.92	2.31	28	34	-5	20
Fourth	0.29	0.69	4.23	2.02	15	27	-3	18
Highest	0.18	0.45	1.71	1.05	31	36	27	27

Source: World Bank (2006, 79).

quintiles. Table 3.4 documents the annual growth in road length in Nepal by construction and road type. In terms of construction type, gravel roads expanded the most between 1995 and 2002, with a 7.9 percent annual growth rate. In terms of road type, district roads expanded by 10.7 percent annually relative to urban roads (6.5 percent), feeder roads (1.3 percent), and highways (1 percent). Table 3.5 illustrates the lack of penetration of extension services to farmers. Only 5.6 percent had received any agricultural extension advice in the past year, while 13.7 percent had received some veterinarian advice. Despite these low rates of use, most farmers responded

Table 3.4 Road length in Nepal, by construction and type, 1995 and 2002 (kilometers)

Construction type	Annual growth			Road type	Annual growth		
	1995	2002	(percent)		1995	2002	(percent)
Blacktop	3,533	4,781	4.4	Highway	2,831	3,029	1.0
Gravel	2,662	4,520	7.9	Feeder road	1,679	1,832	1.3
Earthen	4,529	7,534	7.5	District road	4,799	9,775	10.7
				Urban road	1,415	2,198	6.5
Total	10,724	16,835	6.7	Total	10,724	16,835	6.7

Source: World Bank (2006, 77).

Table 3.5 Access to government extension services in Nepal, 2003/04 (percent)

Response	Agricultural extension advice	Veterinarian extension advice
Yes	5.57	13.7
No	94.43	86.3
Why not?		
Service too far	12.74	10.94
Poor service	4.46	3.51
No need	77.71	82.19
Other	5.09	3.36

Source: World Bank (2006).

that their primary reason for not obtaining extension advice was their perception that they did not need it. Irrigation access, specifically to canal irrigation, also increased between 1995/96 and 2002/03, by 12 percentage points, and the share of area irrigated increased by 15 percentage points (World Bank 2006).

This review of rural expenditures in agriculture, irrigation, and roads reveals large regional and sectoral variations in public expenditures. Although expenditures generally increased over this period, access to extension services remained low, while access to roads and irrigation expanded. In the next several chapters we will apply more rigorous approaches to investigate the impact of access to public infrastructure and services on the observed patterns of welfare outcomes.

Hedonic Approaches to Estimating the Impact of Access to Public Infrastructure and Extension: Methodology and Results

There is a large set of economic literature on measuring the impact of rural investments, including Jimenez (1995); Jacoby (2000); Fan, Zhang, and Zhang (2002); Mogue, Ayele, and Paulos (2008); and Dercon et al. (2009). One major challenge in evaluating this impact is to isolate the effects that are solely attributable to rural investments and not to other unrelated effects that may simply be correlated with household or district characteristics. In assessing the impact of rural investments, it would be extremely difficult to design a counterfactual scenario against which to compare differences, as in the case of a randomized experiment. In the literature, several different approaches are used to measure the impact of access to public infrastructure and rural services. Each approach has advantages and disadvantages. Given the trade-offs of different approaches, this research monograph reports the results of two different econometric methods used to generate a range of estimates of the impact of agricultural public spending on household welfare. The first method is a hedonic approach like that developed by Jacoby (2000), using land values to capture the potential increase in future income streams generated by welfare-increasing rural investments. The second method uses panel data to estimate the effects of lagged access to infrastructure and services on welfare indicators, controlling for the initial conditions of the household (Dercon et al. 2009). The alternative specification serves as a robustness check for the different methodologies of identifying the impact of access to publicly funded infrastructure and rural services.

A necessary precondition for both types of analysis is adequate data sources. We have three different data sources for evaluating outcomes. This monograph draws primarily on household survey data from Nepal Living Standards Surveys 1 and 2 (NLSS 1 and 2) (Nepal, CBS 2004; World Bank 2006), for

which a subset of repeated observations between the surveys exist. The household data are from a nationally representative multitopic household survey that sought information such as agricultural income, land and consumption expenditures, as well as some variables related to infrastructure and public services, such as travel time to the market, access to irrigation, and receipt of visits from an agricultural extension officer. The third set of data provides information on district-level conflict as measured by Maoist and government deaths by year, which were collected and compiled by the Informal Sector Service Centre in Nepal. The hedonic method and its results are described in this chapter, while the panel data approach is described in Chapter 5.

A Hedonic Approach

Jacoby (2000) suggested an innovative hedonic approach to measure the benefits of rural roads at the household level using the value of farmlands and their distance to agricultural markets. Because land is an asset whose value is the discounted stream of agricultural profits, land values should increase as their distance to markets decreases, a direct result of the installation of rural roads. This is because better roads and better access to roads decrease transportation costs, increasing agricultural profits. The same argument can be extended to access to irrigation and agricultural extension services. Better irrigation facilities and more frequent visits from extension agents increase yield and boost land productivity.

We extend Jacoby's identification strategy in several ways. First, we include extension services as an additional determinant in our econometric specification. The effect of extension services on land values provides an estimate of the benefits of extension services. Second, Jacoby included canal and tubewell irrigation as land characteristics. Because both of these types of irrigation are financed by public expenditures, we create a new indicator variable that is the union of the tubewell and canal variables to permit an estimate of the overall effect of irrigation. Finally, we include in the 2003/04 specification a conflict indicator that is the logarithm of the cumulative number of conflict-related killings at the district level. This controls for potential conflict-related impacts on our parameter estimates as suggested by other studies of the impact of conflict on household-level outcomes in Nepal, such as Murshed and Gates (2005), Do and Iyer (2009), and Macours (2009). Because the conflict had not escalated during the 1995/96 survey round, no conflict variable is included. Our modification of the Jacoby specification is as follows:

$$y = \alpha K + \beta X + \gamma D + \varepsilon, \quad (4.1)$$

where y is the hedonic plot value in logarithm; K is a set of rural infrastructure variables, including travel time to the closest market in logarithm, access to irrigation, and whether the household received a visit from extension agents; X is a set of household characteristics; and D stands for a vector of district fixed effects.¹ District fixed effects control for variations across districts, including physical characteristics such as terrain, agroecological potential, and previous public investments, as well as unobservable characteristics of the district such as political influence or public leadership. Equation 4.1 is estimated in a cross-section of data, so we omit time subscripts for simplicity. This equation is first estimated for the 1995/96 NLSS survey round and then for the 2003/04 NLSS 2 survey round. Differences in coefficients across rounds imply changes in the impact of access to rural infrastructure and extension nationally, because the survey rounds are nationally representative.

Hedonic Estimates of the Benefits of Rural Investments

Table 4.1 presents the estimation results for 1995/96 and 2003/04, respectively, based on the hedonic approach using NLSS 1 and 2 data.² In the first specification, using the first wave of data, we include district fixed effects. In the second specification, using the second wave of data, we include district fixed effects and a conflict variable that captures the intensity of conflict as represented by the number of conflict-related deaths over that time period. By explicitly including the conflict variable, we ensure that our results are robust to this potentially disruptive shock in public services and household welfare.

Comparing the point estimates across the two surveys illustrates the increasing benefits of rural roads. In the 1995/96 period, the elasticity of travel time on plot value was 0.261, implying that a 10 percent reduction in travel time would increase plot value by 2.61 percent. The results for 1995/96 are reasonably similar to those of Jacoby, although we have included extension services as an additional variable in the specification. The coefficient for the road variable greatly increased, to 0.471, in 2003/04. These large impacts were driven in part by the rapid increases in median land values, from NPR 16,000 in 1996 to NPR 50,000 in 2003. They also may overestimate the actual

¹ We omit several of the plot quality variables found in Jacoby (2000) because the corresponding survey questions were not included in the 2003/04 round of the NLSS. In Table 4.1, we demonstrate that the modifications proposed earlier and the omission of the plot quality variables still yield coefficient estimates of the impact of the reduction in travel time that are quite close to those estimated by Jacoby (2000).

² Note that the point estimates in Table 4.1 with respect to travel time are not substantially different from those reported in Jacoby (2000). Hence, our minor modifications to the econometric specification do not alter our estimates of the benefits.

Table 4.1 Estimating the impact of access to rural infrastructure and extension services in Nepal using a Hedonic approach, 1996-2003

Variable	Plot value, 1996	Plot value, 2003
Ln travel time in hours	-0.261*** (0.055)	-0.471*** (0.045)
Ln plot size in hectares	0.530*** (0.027)	0.660*** (0.022)
Lowland plot (1 = Yes)	0.208*** (0.053)	0.288*** (0.047)
Seasonal plot (1 = Yes)	0.266*** (0.073)	0.147** (0.066)
Year-round plot (1 = Yes)	0.445*** (0.086)	0.212*** (0.071)
Irrigation (1 = Yes)	0.143** (0.069)	0.196*** (0.068)
Extension visit received (1 = Yes)	0.042 (0.079)	0.085* (0.044)
Ln killings per district (2000-02)		0.052
Constant	10.25*** (0.134)	12.49*** (0.210)
Observations	9,676	8,668
R-squared	0.557	0.603

Source: Authors' calculations.

Notes: Robust standard errors are in parentheses. District fixed effects are included. Ln means log normal; *** means $p < 0.01$; ** means $p < 0.05$; * means $p < 0.1$.

impact of roads, because many households do not own land in Nepal, so these impacts apply conditionally only to landholders. These effects, although high with respect to land, may not transfer one to one into increases in household welfare, because land is an illiquid asset whose stream of income may be difficult to realize given the financial market underdevelopment in rural areas and incomplete land markets.

Access to irrigation also has potentially large effects on land value. We consider the effect of irrigation on land values, defining irrigation as canal irrigation that is primarily constructed for use by multiple farmers in community associations or cooperatives and tubewell irrigation as that individually allocated to a particular farmer on a particular plot. In Table 4.1, we see a positive, statistically significant increase in the effect of irrigation in 1995/96 and 2003/04 of 5.3 percentage points. The increase in the effect of irrigation suggests that the impact of access to irrigation was increasing over this time period, although we cannot test this formally. This could have been due

to improvements in the installation of canal irrigation systems, to farmers' adaptation to using canal irrigation, or to better community organization to manage water resources. In Table 4.1, we also observe a possible increase in the impact of extension services. In 1995/96, receiving an extension visit increased land value by 4.2 percent, but this estimate is not statistically significant. However, in 2003/04, extension visits increased land value by 8.5 percent, which is statistically significant at the 5 percent, one-sided level.

Jacoby's approach addresses several econometric problems unresolved by previous estimates of the impact of rural road projects. These include the endogeneity of locational decisions inherent in compensating variations relating consumption and the distance to markets. One problem of this approach is that it evaluates only one outcome variable, agricultural land values, even though in rural areas, landless labor is common. By looking at only agricultural land values, this approach omits the impact of infrastructure on those people without land. In addition, travel time is affected not only by distance to roads but also by travel mode. With the increasing availability of motorcycles, it is possible to see a drop in travel time even if there is no change in access to roads. Finally, concerns about bias in parameter estimates due to household unobservables are difficult to address in this cross-sectional approach. Unobservable household characteristics such as motivation or entrepreneurial ability are likely correlated with access to services such as irrigation or extension services. Although the hedonic approach does account for the endogeneity of locational decisions, these other sources of household unobservables are potential concerns. The advantage of Jacoby's approach is that it provides an advance in econometric technique over previous methods to evaluate the impact of access to rural infrastructure and services. This approach provides an important comparison for the panel data approach presented in the next chapter.

Panel Data Approaches to Estimating the Impact of Access to Public Infrastructure and Extension: Methodology and Results

The two rounds of NLSS household survey data have a panel component of 962 households, of which 784 are rural households. Therefore, we can use this panel dataset to estimate the impact of public infrastructure on consumption growth, an approach similar to that used by Dercon et al. (2009). Our basic model builds on the growth literature to estimate the effect of access to public infrastructure and services on consumption growth, poverty status, and agricultural income growth, controlling for initial household endowments and economic shocks using the following specification:

$$\ln(Y_t) - \ln(Y_{t-1}) = \delta \ln(Y_{t-1}) + \alpha K_{t-1} + \beta X_{t-1} + \gamma S_{t-1} + \varepsilon, \quad (5.1)$$

where \ln is an abbreviation for *log normal*; t stands for 2002/03 and $t-1$ refers to 1995/96; Y_t is defined as per capita consumption or agricultural income in 2003/04; K_{t-1} includes a set of public infrastructure variables in 1995/96—travel time in logarithm, access to irrigation, and having received visits from extension agents; X_{t-1} reflects lagged fixed characteristics of the household and the district, such as education level of the household head, the number of working men, the number of working women, landholdings, and whether the household is headed by a female, as well as district characteristics such as the cumulative conflict variable that represents the number of killings in each district, the population size of the district in 1996, and the percentage of persons of Brahman ethnicity in the district, which potentially controls for political influence; S_{t-1} represents transitory shocks, such as rainfall and price changes; and ε is an error term.

Estimating Equation 5.1 using ordinary linear square regressions will generate biased results because the lagged per capita consumption variable is correlated with the error term. We address this issue by using a generalized method of moments (GMM) estimator. Following Dercon et al. (2009), we instru-

ment $\ln(Y_{t-1})$ using household and district characteristics observed for 1995/96, including log fertile landholdings, log asset holdings, and log district characteristic of the difference in the elevation within the district. The GMM approach provides consistent and efficient estimation (Wooldridge 2002). To test the reliability of the instruments, we also perform the Hansen-Sargan test of overidentifying restrictions, which verifies whether the instruments are uncorrelated with the error term and are correctly excluded from the equation. We also report the first-stage F statistics.

Panel Estimates of the Benefits of Rural Investments

Table 5.1 reports the results of solving Equation 5.1 for growth in per capita consumption and per capita agricultural income (Columns 1 and 3) in rural households. In order to capture distributional effects, we also present the estimation results as to whether rural investments have effects on poverty status (Column 2). Across all three specifications, we see a common pattern of results. First, the variable for lagged consumption per capita or agricultural income per capita is statistically significant and negative in all three specifications. This suggests that there is convergence in household welfare consistent with the theoretical predications of the growth literature. However, the results as to the effects of consumption growth must be interpreted with caution. The instruments for lagged consumption in 1995/96 do not pass the Hansen-Sargan test, although the instruments do in the other specifications. This suggests that the consumption growth results may suffer from poor instruments. Many other sets of instruments were attempted, but a set of instruments consistent with the literature and across specifications was not found. The F statistics across specifications are strongly significant.

Second, the effect of travel time on changes in household welfare is consistently significant across specifications. Its effect on per capita agricultural income growth is 3 percentage points higher than its effect on per capita consumption growth, perhaps because many households rely heavily on remittances to smooth consumption. Increasing access to rural roads also has distributional consequences. The likelihood of escaping poverty increases by 0.51 percent for a 10 percent reduction in travel time. Third, we find no statistically significant effects of irrigation or extension services. This result is not fully consistent with respect to the hedonic results for extension and irrigation.

There may be several reasons for the lack of impact of irrigation and extension on consumption and income growth. First, irrigation and extension may have a level effect on consumption and agricultural income but a smaller growth effect. This is especially true because not all households own land or

Table 5.1 Estimating the impact of access to rural infrastructure and extension services in Nepal using a generalized method of moments (GMM) approach, 1996

Variable	Consumption growth	Poverty	Agricultural income growth
Columns 1 and 2 variable: Ln of 1996 consumption per capita	-0.547*** (0.109)	-0.260*** (0.094)	-0.844*** (0.154)
Column 3 variable: Ln of 1996 agricultural income per capita			
Extension visit in 1996 (1 = Yes)	0.091 (0.087)	-0.050 (0.058)	0.157 (0.130)
Irrigation access in 1996 (1 = Yes)	0.044 (0.037)	-0.007 (0.035)	0.136 (0.084)
Ln travel time in hours	-0.052*** (0.016)	0.051*** (0.014)	-0.101*** (0.029)
Ln landholdings in hectares in 1996	-0.007 (0.017)	-0.018 (0.016)	0.009 (0.029)
Ln killings per district (2000-02)	-0.048* (0.027)	0.033 (0.027)	0.102** (0.045)
Ln district population in 1996	0.044 (0.032)	-0.006 (0.029)	-0.128** (0.056)
Ln district land size	-0.130*** (0.037)	0.099*** (0.033)	-0.143* (0.079)
Ln percentage of Brahman ethnicity in district	0.109 (0.095)	-0.138 (0.092)	-0.209 (0.167)
Constant	7.678*** (1.700)	-0.016 (1.518)	14.37*** (4.344)
Observations	730	730	647
R-squared	0.323	0.152	0.359
F statistic	32.60***	32.60***	15.37***
Hansen-Sargan statistic	20.55***	3.93	2.45

Source: Authors' calculations.

Notes: Robust standard errors are in parentheses. Ln means log normal; *** means $p < 0.01$; ** means $p < 0.05$; * means $p < 0.1$. The panel is restricted to the rural subsample, and several observations have been dropped due to missing data. All estimates have been made using a GMM-IV approach in which Ln of consumption and agricultural income per capita in 1996 were instrumented by Ln of asset holdings in 1996, Ln of arable landholdings in 1996, and the difference in district elevation. Ln number of working men in household, Ln number of working women in household, education of the household head, and indicators of female-headed household, rainfall, and price shocks were included in the regression but not displayed in the table.

Table 5.2 Robustness checks of generalized method of moments (GMM) estimates in Nepal, 1996

Variable	Consumption growth	Poverty	Agricultural income growth
Original estimates from Table 5.1			
Extension visit in 1996 (1 = Yes)	0.091 (0.087)	-0.050 (0.058)	0.157 (0.130)
Irrigation access in 1996 (1 = Yes)	0.044 (0.037)	-0.007 (0.035)	0.136 (0.084)
Ln travel time in hours	-0.052*** (0.016)	0.051*** (0.014)	-0.101*** (0.029)
Limited information maximum likelihood			
Extension visit in 1996 (1 = Yes)	0.079 (0.091)	-0.057 (0.058)	0.174 (0.131)
Irrigation access in 1996 (1 = Yes)	0.036 (0.038)	-0.010 (0.035)	0.135 (0.086)
Ln travel time in hours	-0.056*** (0.017)	0.048*** (0.014)	-0.102*** (0.030)
Rain and price shocks dropped			
Extension visit in 1996 (1 = Yes)	0.089 (0.087)	-0.051 (0.057)	0.154 (0.131)
Irrigation access in 1996 (1 = Yes)	0.038 (0.037)	-0.004 (0.035)	0.125 (0.082)
Ln travel time in hours	-0.057*** (0.016)	0.055*** (0.014)	-0.109*** (0.030)
Conflict variable dropped			
Extension visit in 1996 (1 = Yes)	0.084 (0.087)	-0.049 (0.058)	0.159 (0.129)
Irrigation access in 1996 (1 = Yes)	0.043 (0.037)	-0.008 (0.035)	0.144* (0.084)
Ln travel time in hours	-0.055*** (0.017)	0.054*** (0.014)	-0.094*** (0.029)
Rain, price, and conflict variables dropped			
Extension visit in 1996 (1 = Yes)	0.074 (0.086)	-0.044 (0.057)	0.156 (0.130)
Irrigation access in 1996 (1 = Yes)	0.035 (0.037)	-0.004 (0.035)	0.135 (0.082)
Ln travel time in hours	-0.060*** (0.016)	0.059*** (0.014)	-0.104*** (0.030)

Source: Authors' calculations.

Notes: Robust standard errors are in parentheses. Ln means log normal; *** means $p < 0.01$; ** means $p < 0.05$; * means $p < 0.1$. All variables included in Table 5.1 (with the exception of those dropped as robustness checks) were included in all the regressions estimated here, but we omit the full results for brevity.

have access to irrigation.¹ Second, for those households that do have access to irrigation, the fact that the growth equations are defined at the household level rather than at the plot level, as in the hedonic specification, may also render parameter estimates less precise because not all of a household's plots may be irrigated, but the household is identified as having access to irrigation if any plot is irrigated. Third, the extension service was largely disrupted by civil strife later in the survey period. Therefore, the measure of extension visits in the initial 1995/96 survey period may not represent the true degree of extension service received by farmers in 2003/04.

Because of the sensitivity of GMM estimates to changes in specification, we re-estimate a series of alternative specifications in Table 5.2. These changes include reestimating Equation 5.1 using a limited-information maximum-likelihood estimator as opposed to the GMM estimator. We also vary the set of covariates included in the specification, dropping various combinations of shock variables, including the rainfall and price shocks, then the conflict variables,² and finally all three sets of shocks. The coefficient estimates compared with the original estimates from Table 5.1 are presented in Table 5.2. These robustness checks suggest that the coefficient estimates are insensitive to these changes in specification or estimator, with most coefficients relatively stable. All results with respect to travel time remain statistically significant at the 1 percent level, while our results for irrigation and extension remain statistically insignificant.

One should also be aware of the disadvantage of using this panel data approach. By the second wave of the household surveys, the panel households were older than the average households in the cross-section. This means that analysis based on panel households may underestimate or overestimate the effect of infrastructure on older households, because they may benefit more (or less) than younger households. In addition, the infrastructure and extension variables were initial values in 1996 in the growth regressions and do not reflect any changes in these variables and the resultant impact on the outcome variables. Both hedonic and panel data approaches provide a robustness check that enables us to derive the key findings that rural road investments have a strong effect on household welfare.

¹ When we restrict the regressions in Table 5.1 to the set of landholders, we find no difference in the statistical significance of the irrigation variable. This suggests that the unit of analysis may be driving the nonresult rather than the specific subsample on which the specification is estimated.

² In Table 5.1, we also note the positive coefficient of the conflict variable on agricultural income growth. This relationship seems inconsistent, which could be due to the endogeneity of the conflict variable or to measurement. Our results on the impact of publicly funded rural infrastructure and services are robust to these concerns, as we demonstrate in Table 5.2.

Conclusion

This research monograph provides a quantitative assessment of the impact of access to rural roads, irrigation, and extension in Nepal using different methods and alternative data sources. Understanding the impact of access to infrastructure and extension services is crucial for policymakers in making public investment decisions as well as formulating development policy strategy, such as that of the Ninth Five-Year Plan. With better information about how strategies have or have not had an impact, future planning and more efficient resource allocation can help improve rural welfare. Although, in principle, the estimation of the impact of access to infrastructure and extension services is paramount for policymaking, significant econometric challenges complicate the exercise. Our econometric strategy builds on the hedonic approach proposed by Jacoby (2000), which relates access to public infrastructure and services to the land value of plot holders using two cross-sections of nationally representative data. We also use a panel of households to investigate the effect of access to irrigation, roads, and agricultural extension on household consumption growth, poverty status, and agricultural income following Dercon et al. (2009). The use of diverse identification strategies reduces the risk of using a narrower set of results driven primarily by a particular methodology.

Robust across different methodologies are the results that rural investments in roads have welfare-improving effects on households as measured by land values, consumption growth, poverty reduction, or agricultural income growth. We estimate statistically significant impacts of irrigation using a hedonic model in both cross-sections of data but find that the impact is insignificant although positive when estimated in a panel household dataset. This inconsistency may be due to measurement inaccuracies of the irrigation variable at the household level, which is aggregated from the plot level, rather than to true ineffectiveness. In our hedonic estimates of the effect of extension on land values in 1995/96, we find that access to extension had a positive yet insignificant effect, while our 2003/04 estimates suggest a larger, statistically significant effect. However, in the panel household analysis, we

find that access to extension in 1995/96 did not have a significant impact on growth in household welfare. Due to civil strife, the initial frequency of extension visits might not have been related to agricultural productivity and other welfare indicators seven years later. The inconsistency of the estimated impact of extension service between the two methods calls for more in-depth research in the future.

Interpretation of these results with an understanding of the political economy of Nepal over the period of analysis is critical. Because of the disruptions of extension services caused by civil strife, the initial frequency of extension visits in 1995/96 may not matter much to income and consumption growth in the period from 1995/96 to 2003/04. During the conflict, agricultural extension agents might have had valid excuses for not visiting farmers in rural areas for safety reasons. Now that peace has been restored in rural areas, the barriers to access to public infrastructure and services have been lowered. However, the effective delivery of irrigation and extension service and the construction and maintenance of roads can continue to be improved. The underlying approach of the APP, which emphasizes unlocking the growth potentials of rural farmers by exploiting the comparative advantage of Nepal's unique agroecological environment, is basically sound. Linking farmers to the market through rural roads and enhancing land productivity through irrigation and extension services are ways to potentially help Nepalese farmers exert their comparative advantages. There is a need for further research on improving the effectiveness of rural infrastructure and services and understanding the channels of their impact on rural households' welfare in the more stable environment.

References

- ANZDEC Limited. 2002. *Nepal agriculture sector performance review*, vols. 1 and 2. Auckland, New Zealand.
- Dercon, S., D. O. Gilligan, J. Hoddinott, and T. Woldehanna. 2009. The impact of agricultural extension and roads on poverty and consumption growth in fifteen villages. *American Journal of Agricultural Economics* 91 (4): 1007-1021.
- Do, Q.-T., and L. Iyer. 2009. *Geography, poverty, and conflict in Nepal*. Harvard Business School Working Paper 07-065. Cambridge, Mass.: Harvard Business School. <<http://www.hbs.edu/research/pdf/07-065.pdf>>.
- Duflo, E. 2006. Field experiments in development economics. In *Advances in economics and econometrics: Theory and applications: Ninth World Congress*, vol. 2, ed. R. Blundell, W. K. Newey, and T. Persson. Cambridge, U.K.: Cambridge University Press.
- Fan, S., L. Zhang, and X. Zhang. 2002. *Growth, inequality, and poverty in rural China: The role of public investments*. Research Report 125. Washington, D.C.: International Food Policy Research Institute.
- Jacoby, H. 2000. Access to markets and the benefits of rural roads. *Economic Journal* 110 (465): 713-737.
- Jimenez, E. 1995. Human and physical infrastructure: Public investment and pricing policies in developing countries. In *Handbook of development economics*, ed. J. Behrman and T. N. Srinivasan. Amsterdam, Netherlands: North Holland, Elsevier.
- Macours, K. 2009. *Relative deprivation and civil conflict in Nepal*. Working paper. Washington, D.C.: School of Advanced International Studies, Johns Hopkins University. <http://www.sais-jhu.edu/bin/s/k/macours_civilconflict_dec09.pdf>.
- Mogues, T., G. Ayele, and Z. Paulos. 2008. *The bang for the birr: Public expenditures and rural welfare in Ethiopia*. Research Report 160. Washington, D.C.: International Food Policy Research Institute.
- Murshed, M. S., and S. Gates. 2005. Spatial-horizontal inequality and the Maoist insurgency in Nepal. *Review of Development Economics* 9 (1): 121-134.
- Nepal, Central Bureau of Statistics (CBS). 2002. *Population census 2001: National report*. Kathmandu, Nepal: National Planning Commission.
- . 2003. *Statistical yearbook and statistical pocket book*. Kathmandu, Nepal: Central Bureau of Statistics.
- . 2004. *Nepal living standards survey*, vols. 1 and 2. Kathmandu, Nepal: Central Bureau of Statistics.
- Nepal, National Planning Commission (NPC). 1995. *Agriculture perspective plan*. Kathmandu, Nepal: National Planning Commission.

- Wooldridge, J. 2002. *Econometric analysis of cross section and panel data*. Cambridge, Mass.: MIT Press.
- World Bank. 2000. *Nepal public expenditure review*, vol. 1: *PER overview—The main report*. Report 20211-NEP. Washington, D.C.
- . 2006. *Nepal: Resilience amidst conflict*. Report 34834-NP. Washington, D.C.
- . 2007. *Nepal public expenditures data set, 1999-2003*. Kathmandu, Nepal.

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DURING THE PERIOD OF NEPAL'S NINTH FIVE-YEAR PLAN (1997–2002), agricultural growth in the predominantly rural society was disappointing. The recent peace process, however, gives the country new opportunities to develop its economy with less interference due to internal conflict. This research monograph investigates how Nepal might seize these opportunities by increasing agricultural growth and poverty reduction through improvements in roads, irrigation, and rural extension. The authors evaluate the impact of public investments in these areas by using two types of data and methodology: a hedonic approach that relates access to public infrastructure and services to land value and a panel of household-level data on consumption, poverty, and income. The hedonic methodology suggests a positive relationship between investments in irrigation and extension and household welfare, although the panel data approach suggests otherwise. This result reinforces the importance of methodology in evaluating rural investments. Rural roads yielded more clear-cut findings, however: both approaches agree that investment there has a positive relationship with household welfare, as measured in land values, consumption growth, poverty reduction, or agricultural income growth. The authors recommend increased public investments in rural roads, irrigation, and extension, as well as further research into precisely how infrastructure and services affect rural households' welfare and how their effectiveness can be improved. This monograph will be useful to policymakers, researchers, and others concerned with Nepal's future development.

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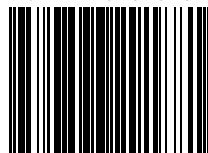
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