Impacts of the MCC Transportation Project in Nicaragua

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Abbreviations

AADT	Annual Average Daily Traffic
ERR	Economic Rate of Return
FIDEG	Fundación Internacional para el Desafío Económico Global
INIDE	Instituto Nacional de Información de Desarrollo
IRI	International Roughness Index
MCA-N	Millennium Challenge Account-Nicaragua
MCC	Millennium Challenge Corporation
MTI	Ministry of Transport and Infrastructure
NPV	Net Present Value
RBD	Rural Business Development Project
TPM	Transportation Project Management
VOC	Vehicle Operating Cost

Executive Summary

The Millennium Challenge Corporation (MCC) signed a five-year, $175 million compact with the Government of Nicaragua in July of 2005. The compact included three projects, a Property Regularization Project, a Rural Business Development Project and a Transportation Project (MCC 2009). The goals of the compact were to reduce transportation costs and improve rural communities' access to markets, to increase wages and profits from farming and related enterprises in the region and to strengthen property rights with the aim of increasing investment, productivity, and wealth.

The project was implemented by the Millenium Challenge Account – Nicaragua (MCA-N), and this document provides preliminary evidence on the economic impact of the transportation component of the compact, which ultimately consisted of significant upgrades to three roads; one secondary trunk road and two secondary roads, totaling 68 kilometers in length. The total cost of the transportation project, including administration, monitoring, and evaluation was $65.7 million (2011).

Project construction activities took place in the northwest of the country in the Departments of Leon and Chinandega. The secondary roads in the project are S1 and S9. S1 is located in the north of Chinandega linking Somotillo and Cinco Pinos. S9 connects the urban center of León to the oceanfront communities of Poneloya and Las Peñitas. The secondary trunk road VG connects Villanueva to the Honduran border at El Guasaule, providing a potentially important link to trade partners across the border. Figure 1 in the main text maps the project area.

To determine the impact of the transportation project, the net benefit from reduced transportation costs to road users is calculated using pre- and post-construction traffic counts, and estimates of future traffic flows. The calculations generate an overall rate of return (ERR) for each project road and the Transportation Project in aggregate. The ERR represents the discounted flow of net benefits over twenty years, which includes two years of construction and eighteen years of active road use during which the roads receive regular maintenance. Other impacts of the transportation project are measured from surveys of retail establishments that identify changes in the prices and availability of consumer goods in a sample of the affected communities. The report also makes use of household survey data collected for the evaluation of the Rural Business Development Component of the Nicaragua Compact to examine the extent to which the results from the establishment survey appear robust. We provide some general comments on the usefulness of the establishment survey methodology both at the conclusion of this Executive Summary and in the concluding section of the report. Before turning to conclusions and recommendations, this Executive Summary provides an overview of the results from the ERR and the establishment survey.

Economic Rate-of-Return

The ex-post ERR captures the project's flow of net benefits to road users defined as benefits minus costs which are appropriately discounted across time to yield a single value. Benefits arise from savings in vehicle operating costs and travel time. Costs include the discounted flow of road construction and road maintenance expenditures over the lifecycle of the road.

Consistent with MCC guidelines the flow of net benefits over the entire lifecycle of the roads is calculated for discount rates of both 8 percent and 10 percent. The lifecycle cost includes three years of capital costs (2008-2010) and eighteen years of maintenance and repair costs during road operations (2010-2027). Projects yield a net benefit if the ERR is higher than the discount rate or, equivalently, there is a positive net present value (NPV) of net benefits. Since this evaluation comes very early in the life of the project, ERR estimates were calculated using several different modeling assumptions about the rate of traffic growth in future years. Details on the different models are reported in the full text and mean estimates across methodologies are reported in the Executive Summary, Table ES-1. It should be noted that we have varying confidence in the different models included in the average for each road, due to data quality issues that are detailed in the main text. Relative to the most robust models, the averages overstate the ERR.[1] The ERR calculations based on the averages reveal that roads fail to meet the 10% baseline for ERR, with mean estimates ranging from -3.9% for S1 to 4.5% for S9 and an overall project average of 2.1%.

Using the column in Table ES-1 for the S1 road as an example, we observe that the construction effort led to a substantial improvement in road quality. Road roughness as measured by the International Roughness Index (IRI) decreased from 13.2 to 3.88 or 71 percent. Road users responded positively to the change as annual average daily traffic (AADT) increased by 80 percent between the baseline year and the end of the compact, from 206 to 370. Continuing down the column for S1, we observe that at a 10 percent discount rate, the estimated user benefits are $3.71 million, but the costs are $18.56 million. The results are a negative NPV and an ERR lower than the required discount rate under the base case scenario.

Table ES-1. Summary Results from the Economic Rate of Return Analysis

	S1	S9	VG	Program
International Roughness Index				
IRI baseline	13.2	12.0	12.0	12.5
IRI end of compact	3.38	1.84	1.76	2.49
Annual Average Daily Traffic				
AADT baseline (2008)	206	1,052	1,448	2,706
AADT end of compact (2010)	370	1,160	1,532	3,062
AADT end of study period (2027)	635	6,986	3,482	11,103
Net Present Value				
NPV (10%, 2011 US$ mill.)	(14.85)	(6.35)	(7.05)	(28.25)
User benefits	3.71	10.36	9.33	23.40
Incremental costs	-18.56	-16.71	-16.38	-51.65
Economic Rate of Return				
ERR (average across methodologies):	**-3.9%**	**4.5%**	**3.8%**	**2.1%**

[1] Tables 10, 20, and 29 provide details of a sensitivity analysis of ERR results for the preferred model for S9, S1, and VG respectively.

Source: own estimates. Note: Program values for IRI are averages weighted by road length. Program values for AADT are sum totals. Program values for NPV and ERR are aggregate program calculations across three methodologies (time trend, GDP growth, population growth), described fully in the main text.

It should be emphasized that these results are our best estimates of mean impacts based on data collected specifically to measure the impacts of the transportation project including detailed traffic counts from before and after the project's completion. Nonetheless, there remains uncertainty about the magnitude of the ERR that is ultimately realized. The primary reason for the uncertainty is that the post-project data from which the final impacts were calculated was collected less than one year after the road rehabilitation was completed. The literature on infrastructure evaluation suggests that complete adjustment to projects of this type happens more slowly and so a more realistic picture of the benefits are likely to emerge over two to five years from project completion (Mu and van de Walle, 2007; van de Walle 2009). The relatively modest results we observe likely reflect incomplete adaptations to the opportunities associated with the rehabilitated roads. One of our primary recommendations is that the ERR model provided in appendix be updated to track subsequent changes.

The Excel spreadsheet that contains the model is structured so that the ERR can be easily recalculated as new data becomes available. The model's calculations are consistent with the Roads Economic Decision model (RED) developed by the World Bank for ex-ante analysis. For ex-post analyses, we believe the current model is more appropriate than RED due to its increased flexibility. Among other advantages, the model allows for different annual values of relevant data as opposed to one average parameter assumed constant for extended periods as in RED. This aspect is indispensable for monitoring the actual performance of the project year after year (or as often as updated data become available).

While we present our best estimates of mean impacts, if there is a bias we think it more likely that the estimates of the ERRs are conservative. Our approach is consistent with the guidelines developed by the American Association of State Highway and Transportation Officials (AASHTO 2010) who emphasize repeatedly the potential for inappropriate double-counting of benefits through different measurement approaches. For example property values may increase as a result of the improved roads. In fact, although detailed data on real estate values were not available, anecdotal evidence suggests that increases of between 10% and 25% may have occurred in some areas. However, inclusion of changes in property values would likely result in double-counting of benefits since market processes would cause the present value of the flow of benefits to road users to be capitalized in property values. Thus the increase in property values associated with user benefits is captured in the ERR (or at least partially captured in the absence of perfect competition). Following standard practice in the cost-benefit literature, the current analysis adopts a conservative approach.

Establishment Survey

The decrease in travel costs that result from the rehabilitation of the roads directly captures the benefits of the transportation project, but presents an incomplete picture of the impacts of the project on the local population. The broader question of how local and regional economies adjust to these lower costs is a complex one that is partially addressed through a survey of local establishments. The survey provides direct evidence on changes in availability and price of a number of important consumption goods for institutions along the secondary roads, S1 and S9.

To identify the extent of impacts, establishments in both project and non-project areas were visited both before and after the road rehabilitation occurred. The data collected allow for the generation of a credible baseline in non-project communities to which project communities can be compared. The survey collected information from establishments regarding availability and prices of goods included in the *Canasta Basica*, or basic basket of goods that is used in Nicaragua to track consumer prices. There are 53 items in the Canasta Basica including food, clothing, and household goods. The establishment survey can provide suggestive information, for example, identifying goods or categories of goods that benefit from reduced transport costs. Despite the relatively short period of time that has elapsed since the end of the project, the establishment surveys do reveal some significant changes due to the rehabilitated roads.

Central results regarding the cost of goods from the establishment surveys are presented in Table ES-2a. In rural areas, the value of the basket of goods available in treated areas declined on average 0.97% relative to the control group, while urban areas witnessed a 0.91% increase. These relatively small aggregate changes obscure some significant effects in components of the basic basket. In particular, prices for dairy and eggs declined about 20%, likely reflecting the increased ease of transport for perishable and fragile items.

Table ES-2b presents results on the availability of goods at the community level. The availability of goods increased in both project and non-project communities, and although there is a slightly larger increase in project communities it is not a statistically or economically significant effect.

More detailed household surveys were not conducted for the transportation project, however, this evaluation does make use of household surveys that were conducted to evaluate the Rural Business Development (RBD) portion of the Nicaragua Compact. Findings from these surveys are relevant since some households in the RBD sample were in areas affected by the transportation project. The full examination of the RBD survey is beyond the scope of this report, but would also be inappropriate given the purposes of that study – the respondents are not intended to be representative of the overall population so any detailed conclusions on effects would be inappropriate. However, the existence of this data does provide some insight on the robustness of the establishment survey results. In fact, we find corroborating evidence of benefits associated with the perishable and fragile items for which large price declines were observed in the establishment survey; a corresponding increase in consumption was observed for these items in the household survey.

The establishment survey provides evidence that the distribution of some perishable and fragile food items has improved as a result of the transportation project, but that so far the overall effects of the project have been modest. Given the relatively brief time between the completion of the project and the conduct of the follow-up establishment surveys, and evidence from other transportation infrastructure evaluations, it is reasonable to conclude that there will be additional changes in output and availability of goods over time.

Table ES-2a. Summary Treatment Effects, Cost of Basic Basket of Goods

Goods	Location	Cost Ex-Ante	Cost Ex-Post	Difference	% Change
Canasta Basica	Rural	5663.41	5608.47	-54.94	-0.97%
	Urban	7133.17	7197.85	64.68	0.91%

Source: Establishment Survey, 2008 & 2010.

Table ES-3b. Summary Treatment Effects, Availability of Goods in Basic Basket (Community-level Counts)

	Control Communities		Treatment Communities		All Communities	
Statistic	2008	2010	2008	2010	2008	2010
Number of Items	36.00	37.94	35.83	39.75	35.93	38.69
Std. deviation	12.81	11.59	10.82	9.91	11.82	10.78
Observations	17	17	12	12	29	29

Source: Establishment Survey, 2008 & 2010. Treatment Communities are located on roads included in the Transportation Project. Control Communities are located on roads not included in the Transportation Project.

Recommendations and Conclusions

The Transportation Project evaluation has both strengths and weaknesses. An important strength is the collection of data targeted specifically to measure project impacts. The principal data collected include traffic counts and origin and destination surveys which are relevant for estimating the impact of reduced costs of road use, and the establishment survey which provides detailed community-level data on the availability and prices of goods in the basic basket. Ordinarily these data are not collected for rural areas of Nicaragua. The establishment survey has yielded high quality data that facilitates comparisons across diverse communities. Four distinct rounds of data collection were conducted for the establishment survey, with two rounds both before and after the road construction, making the results more robust. This approach to data collection reduces concerns that some random shock such as bad weather or a temporary transportation difficulty would lead to an inaccurate conclusion about the more general conditions in specific communities or establishments.

The establishment survey does have limitations with respect to the type of questions it can address, and an expansion of the scope of the establishment survey could be beneficial if this approach is to be used in future evaluations. Expanding data collection to include quantities as well as prices would be informative for measures of aggregate consumption, as would information regarding shoppers travel routes to the establishments and the location of origin of goods in the establishments. The establishment survey methodology could also be strengthened by surveying additional types of establishments that include schools, hospitals, and sellers of durable goods and equipment.

The establishment survey implemented for this evaluation is an alternative to more detailed and costly household surveys that have been used for infrastructure evaluations. The household surveys provide the opportunity to examine broader measures of well-being that include accessibility to health care, education and other services – as well as nonmarket consumption and consumption of goods purchased outside of community establishments – which is a clear benefit of the household survey that can be better approximated by an expanded establishment survey.

We reiterate a concern regarding the relatively short time span within which follow-up data were collected. The primary data collection through the establishment survey and traffic surveys occurred less than a year after completion of the construction. While these datasets are relevant for identifying the impacts of the Transportation Project, they should not be considered the final word. Numerous adaptations to the improved roads, such as adjustments in agricultural production and distribution are likely to be implemented over a longer range of time. Similarly, it is plausible that entrepreneurial innovations in other sectors that are responsive to the decline in transportation costs can take time to be recognized, introduced, and for their effects to become apparent. Mu and Van de Walle (2007) provide evidence on the importance of allowing sufficient time to pass to assess impacts. They identify minimal effects two years after construction was concluded but more significant changes within five years.

The benefits of reexamining project outcomes at a later date should be weighed against additional costs. One low cost approach to reexamining project impacts would make use of traffic count data from the Ministry of Transportation and Infrastructure (MTI). We find that historical data from MTI tracks closely with the data collected for the project by FIDEG and so MTI data is used to generate the results reported below.

A final benefit of this evaluation is the development of an ex-post model to track economic returns. Existing tools such as the RED Model focus on ex-ante analysis and the new model can be more readily updated as new data on project performance becomes available. This data includes actual traffic counts, maintenance and other costs including real wages, and unexpected changes in the IRI, perhaps due to natural disasters.

The main conclusion is that the efforts made by MCC to collect detailed high quality data in various countries for the specific purpose of conducting impact evaluations are extremely important. Significant resources are devoted to road infrastructure projects by MCC and by other international donors and governments. Increased understanding of the impacts of these investments is needed not only to justify existing projects but also to improve the effectiveness of future projects. The fact that short term effects are small does not diminish the importance of these efforts. In fact, it emphasizes the need to repeat the exercise of collecting and analyzing the same type of data at regular intervals.

1 Background and Objectives

1.1 The Millennium Challenge Corporation in Nicaragua

The Millennium Challenge Corporation (MCC) signed a five-year, $175 million compact with the Government of Nicaragua in July of 2005. The compact included projects in three distinct areas: a Property Regularization Project, a Rural Business Development Project and a Transportation Project (MCC 2009). The goals of the compact were to reduce transportation costs and improve rural communities' access to markets, to increase wages and profits from farming and related enterprises in the region and to strengthen property rights with the aim of increasing investment.

On July 3, 2009, MCC terminated funding under the Compact in response to a pattern of actions by the Government of Nicaragua that were inconsistent with the criteria used by MCC to determine eligibility for assistance. Funding was terminated for all activities in the Property Regularization Project and for activities in the Transportation Project which were not already under contract. Funding under the compact was reduced by $61.5 million to $113.5 million (MCC 2011).

This document provides evidence on the economic impact of the Transportation Project, which after modification due to the compact's termination consisted of the upgrading of one secondary trunk road and two secondary roads totaling 68 kilometers in length at a cost of US $65.7 million.[2]

Figure 1 contains a map of the Project area. The map identifies the secondary roads considered for rehabilitation by the MCA-N. The roads ultimately chosen for rehabilitation include the S1 in the north of Chinandega linking Somotillo and Cinco Pinos, and S9, linking the urban center of León to the oceanfront communities of Poneloya and Las Penitas. Not separately identified on this map is the segment of the CA-3 road, a secondary trunk road, which was rehabilitated from the intersection with S4 at Villanueva to the Honduran border at El Guasaule and is identified as the VG road in this report. .

The process of evaluation and selection of the project sites was facilitated by extensive preparatory studies. A due diligence study authored by the United States Army Corps of Engineers (USACE) for the MCC examined and evaluated general issues related to institutional capacity, environmental and social impacts, and details of the road network and road construction methods (USACE, 2005). Subsequently, MCA-N privately contracted engineering and feasibility studies for all roads under consideration for rehabilitation. As shown in Figure 1, these include the trunk roads R1, and R2, secondary roads S1 through S13, and the previously mentioned VG road. Estimates of Internal Rates of Return from the pre-project feasibility studies (TYPSA-AZTEC 2008a, 2008b; ROCHE 2008) are presented in Table 1. Leaving aside the trunk roads, which were excluded from consideration due to compact termination, the roads chosen for the project ranked first (VG), third (S9) and fifth (S1) with respect to mean values of high and low IRR scenarios.

Among the objectives of the current study are the calculation of ex-post economic rates of return for the individual roads and the transportation project as a whole. This report updates the ex-

[2] Tasks associated with the scope of work for the evaluation are included in Appendix A.

ante rates of return calculated in the feasibility studies by incorporating the most current information on costs and benefits, drawing from those previous studies information and conclusions that remain relevant, and using a similar methodological approach. The approach is based on the RED model developed by the World Bank and recommended for low volume rural roads; it is a simplified version of the HDM4 model used in the feasibility studies. As noted in the Executive Summary and as explained in detail in the following chapters, we find Economic Rates of Return significantly lower than those estimated in the feasibility studies. The differences are primarily due to actual capital costs on average 2.2 times as large as those estimated in the feasibility studies. For each road the actual versus projected are roughly $24 vs $8 for S1, $21 vs $6 in S9, and $21 vs. $16 for VG, with all estimates in millions of US dollars in 2011. Estimated benefits in the feasibility studies are roughly consistent with the user benefits we estimate ex-post.

Figure 1. Transportation Project

Table 1. Economic rates of return from feasibility studies

Road	R12	VG	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12	S13
IRR Low (%)	46.8	21.5	8.0	-3.9	-3.3	2.3	-0.4	3.8	11.5	5.0	11.2	4.5	4.4	8.5	NA
IRR High (%)	53.9	25.6	8.9	4.6	6.4	3.3	5.3	5.3	13.6	7.3	13.7	6.2	5.4	9.7	NA

Source: MCC Documents

1.2 Rural Roads and Development Outcomes

The importance of rural roads for economic development has been discussed in numerous contexts. An early advocate in the economics literature was Muhamad (1938) who discussed the expansion of rural road networks in India, arguing that budgets concentrating on education and health projects should be refocused to also prioritize road construction. The need to rank priorities and find the proper balance among the variety of possible development programs remains a challenge, and highlights the need to objectively examine project outcomes both for purposes of accountability and to inform subsequent decisions. For road construction and improvement projects, benefits to users associated with reduced travel time, fuel use, and wear on equipment figure most prominently. However, the argument for the importance of rural road development has not always been a narrow one that focused solely on transportation costs. Muhamad argued for the importance of outcomes that included increased access to education and health care as well as social and cultural benefits associated with increased interaction with urban centers.

More recently, in a review article, van de Walle (2009) reemphasizes the potentially broader effects of infrastructure development, noting that rural roads can lead to significant restructuring of economic activity that includes changes in intensity or character of land use, better access to inputs and to a broad array of consumption goods. Macroeconomic studies support these claims, finding evidence of significant complementarities between public infrastructure investment, including roads, and private investment (Agenor and Montiel 1999).

The macroeconomic relationships are suggestive, but also highlight the importance of identifying the direction of causality between road development and economic development. The macroeconomic studies find it difficult to determine whether it is road-building that spurs economic development, or alternatively whether it is in regions that are already growing where infrastructure investments are more likely to occur. The modern microeconomic literature has tried to address the question of the direction of causality. Estache (2010) reviews a wide variety of microeconomic approaches to infrastructure evaluations that include ports, railways, rural roads, and highways. He identifies critical challenges, particularly with respect to constructing an appropriate comparison or control group for communities receiving new or improved infrastructure – the treated - in order to measure project impacts. Experimental approaches that make random assignment to treatment and control are the typical method for generating comparison groups, however, randomization of locations for infrastructure projects is extremely unusual and difficult to accomplish and was not attempted for this study.

The most useful methods for evaluating impacts require that outcomes are observed before and after the infrastructure improvement, among both treatment and control groups along with auxiliary data on location characteristics. Difference-in-differences estimators calculate impact by subtracting the differences in the control group outcomes from those in the treated group to identify project impacts. Estimates of treatment effects with these tools are most informative if the treatment and control groups are very similar. Results will be biased if the control and treated units differ significantly. To address this issue, regression controls or matching methods are used to adjust for observable differences. Multiple observations before and after a project are also desirable so that trends can be identified (van de Walle 2009). The implementation of these methods requires significant investment in data collection, and we outline the efforts taken to address data needs for the Transportation Project evaluation, below.

A substantive issue that may be illuminated or masked by different data collection strategies is the importance of the timing of changes in economic outcomes. Mu and Van de Walle (2007) investigate outcomes of a large rural road project in Vietnam, both twenty-seven and sixty months after project completion. They study a broad variety of outcomes, distinguishing household welfare (consumption) measures from measures of access to markets, and social services. They find that "few outcomes respond rapidly to the new and improved roads," but that market development and access to services does increase over the longer term. Similar lags in changes in outcomes are noted in other studies (Bell 2012). In the current study we observe changes eight to twenty months after the completion of the rehabilitation projects – a much shorter period than those studied by Mu and Van de Walle (2008). We do observe some significant effects over this relatively short period of time, however, the evidence from previous work suggests that additional adjustments to the new infrastructure are likely over a longer period of time. One of the primary recommendations of this report is that additional data collection supplement the preliminary results reported here.

1.3 Objectives

The evaluation examines impacts of the Transportation Project in three ways. First, we calculate economic rates of return associated with reduced user costs for each rehabilitated road - and for the project in aggregate - making use of the before and after measures of road use, detailed data on project implementation and costs, and models that project changes in usage, costs, and benefits over time.

We also examine changes in the availability and cost of common consumption goods that can be attributed to the transportation project. This component of the analysis relies on a survey of retail establishments that targets goods in the Cansta Basica or *basic basket* that is used in Nicaragua to track consumer prices. Data was collected both before and after construction in communities both on and away from rehabilitated roads. The survey design therefore facilitates measurement of changes in price and availability of goods relative to a relevant comparison group.

The evaluation also examines changes in household consumption using a similar pre- and post-rehabilitation data collection methodology. The consumption measures for this component of the evaluation are derived from responses to household surveys implemented for the Rural Business Development (RBD) portion of the Nicaragua compact. While the bulk of the respondents to this survey are outside the zone of influence of the road rehabilitation, we identify more than one-hundred households within the zone of influence of the rehabilitated roads. It is important to recognize that the data for this component of the report was collected for a different purpose and respondents are not a representative sample of households in the treatment and control areas. Thus these results are intended to be suggestive and provide some insight on the robustness of results from the survey of retail establishments. These surveys do not provide unbiased estimates of the transportation project on the affected population.

2 Data

As noted above, the evaluation process is data intensive and data from a wide variety of sources are used to evaluate the Transportation Project. Data collected specifically for the project include traffic counts and origin and destination surveys that allow the tracking of travel costs and estimation of benefits. Administrative data from official sources that includes wages, and fuel costs and use is also a critical input in the ERR calculation. Establishment surveys in thirty communities were conducted to collect data on price and availability of a basket of consumer goods to shed light on whether the rehabilitated roads provide significant nonuser benefits. The establishment survey contains information on fifty-three items that comprise the Canasta Basica - or basic basket - from which the Central Bank constructs its cost of living index. The fifty-three items in the Canasta Basica are segregated into eight categories that include food items, household costs, and clothing. The full list of items by category is in Table 45.

Prices for the Canasta Basica are collected on a monthly basis by INIDE in Managua, however, collection of this data in rural areas is not routine. Price surveys for project areas were conducted by the private firm FIDEG both before and after the road rehabilitation. In order to generate a counterfactual data was collected in communities both inside (treatment) and outside (control) of the zone of influence of the rehabilitated roads. Communities in the control group did meet a phase one selection hurdle; they were all in the zone of influence of roads considered for rehabilitation by the MCA-N and feasibility studies were conducted for these roads. Roads that passed the initial selection hurdle and were subject to a feasibility analysis are likely to be more similar than a random sample of roads in the regions. Further, matching techniques based on observable characteristics were used for the final selection of communities to be included in the establishment survey as well as in the analysis below (FIDEG 2010). Appendix B identifies the treatment and control communities in the establishment survey.

The Canasta Basica for Managua is updated on a monthly basis. From August 2009, to October 2010 the endpoints of data collection for the Transportation project the Managua index rose from 8,675 Cordoba to 9,267 Cordoba, a total increase of 6.4% over the 15 months. In the surveyed communities the value of the Canasta Basica rose 14.9%, however the number is not readily comparable as the number of items available in different communities changed over this period, while the entire basket remained available in Managua. The availability of items in the basket in treatment and control communities is discussed in detail below.

The establishment surveys, traffic counts, and origin and destination surveys conducted by MCA-N before and after construction occurred were complemented by additional data sources. MTI has conducted traffic counts on project roads and these are used directly in the calculation of user costs. Household survey data from the Rural Business Development project is also used. The survey was implemented three times in 2007, 2009, and 2011. The 2007 and 2011 results are used to estimate pre- and post- rehabilitation impacts on household consumption. Other data is culled from project documentation (TPM reports), feasibility studies, INIDE Census summaries (2009) and the Census data in the region, as well as a variety of data from the Central Bank including data on wages and exchange rates.

Table 2. Critical Dates for Construction and Data Collection

Project	Date1	Date2	Date 3	Notes
Road Construction S1	10/03/2008	1/16/2010		
Road Construction S9	9/30/2008	1/31/2010		
Road Construction VG	8/13/2008	2/11/2010		
Establishment Survey	08/2008	09/2010		FIDEG
Census	2005			INIDE
INIDE (MECOVI)	2005			HH Survey
RBD	2007	2009	2011	HH survey: FIDEG
Origin and Destination Survey	2008	2010		FIDEG
Traffic Surveys (FIDEG)	2008	2010		
Traffic Surveys (MTI)				Various dates

3 Ex-post Economic Rate of Return and Beneficiary Analysis

3.1 Economic Rate of Return Methodology

The analysis follows the MCC's *Guidelines for Economic and Beneficiary Analysis* (MCC 2009), other U.S. federal guidelines for benefit-cost analysis (USDOT 2011, FHWA 2011, OMB 2011), and the methodologies recommended by the Government of Nicaragua (MHCP 2010, SNIP 2011a, SNIP 2011b).

According to MCC (2009), "(t)he minimum acceptable ERR for both programs and individual components of MCC compacts will be the greater of: (a) two times the average real growth rate of GDP for the country for the most recent three years for which data is available; or (b) two times the average real growth rate of GDP for all of the MCC eligible countries for each country for the most recent three years for which data is available. The minimum acceptable ERR shall not be greater than 15 percent." The average real growth rate of the GDP expressed in dollars for 2008-2010 was 5.2, therefore the minimum acceptable ERR for MCC would be at least 10.4 percent. The estimated ex-post ERR of -3.9 percent for the road segment S1 fails to meet the required rate. Both the S9 and VG roads exhibit positive rates of return, 4.5 percent and 3.8 percent, respectively, however, both also fail to meet the target return. .

The analysis captures the project's flow of benefits and costs over a twenty year time horizon that includes a construction period (2008-2009) and an eighteen year road operations period from 2010 through 2027. These flows are discounted over time to reflect the opportunity cost of capital. The analysis uses the two real discount rates recommended by the mentioned guidelines, 8 percent and 10 percent. The summary results include the ex-post ERR and net present value (NPV), two closely related indicators that are useful in project evaluation. The ERR is a summary statistic that represents the discount rate at which the present value of benefits and costs are equal. Support for the economic justification of the project is provided when the ERR is higher than the discount rate or alternatively when the NPV is positive.

The life-cycle costs analysis includes the investment costs and the incremental operation and maintenance costs (O&M) of each project segment compared to the baseline. The investment costs reflect currently available information on the actual ex-post capital construction costs provided by MCC. The O&M were provided by MCC based on estimates from the ex-ante feasibility studies prepared by TYPSA-AZTEC. O&M costs include annual routine maintenance costs and periodic maintenance costs that occur every 6 years. All values are converted into real terms expressed in 2011 dollars unless otherwise noted.[3]

The measurement of user benefits is a key component of the economic rate of return calculation. While a benefit-cost analysis typically attempts to capture all benefits and costs accruing to society from the project, the user benefit analysis evaluates only the travel-related benefits borne or perceived by users of the transportation project. This analysis includes benefits from savings in vehicle operating costs (VOC) and travel time; reductions in accident costs were not included due to lack of data.

[3] The attached excel model can adjust all values to any other reference year.

3.2 User Benefits Methodology

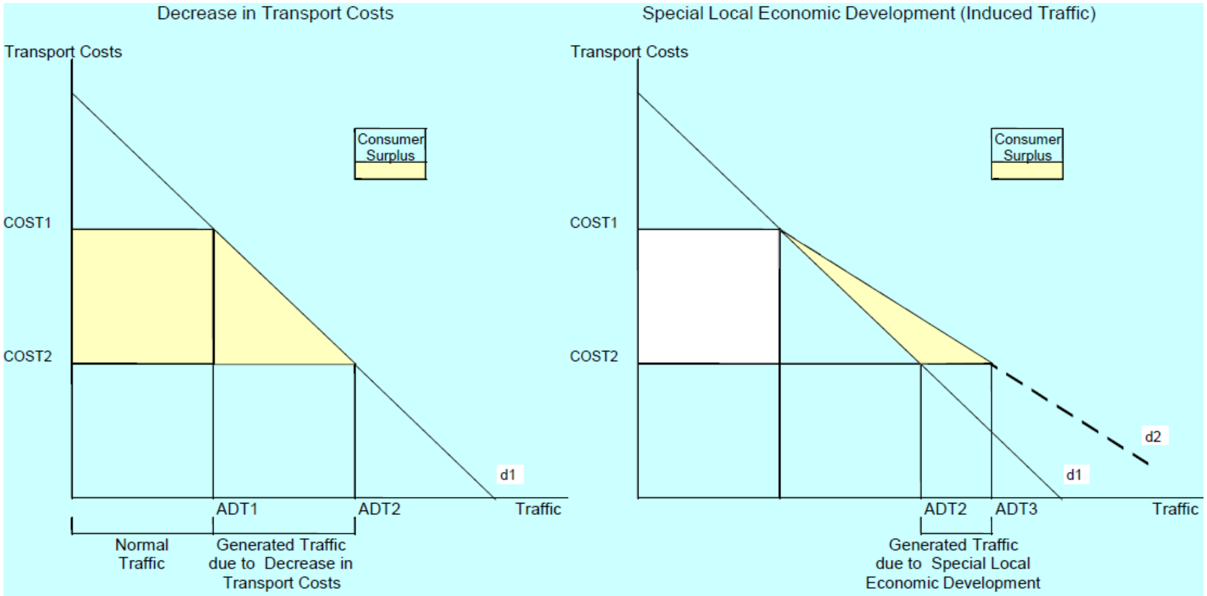
This section describes the methodology to quantify user benefits associated with normal, generated, diverted, and induced traffic following a consumer surplus approach (AASHTO 2010, USDOT 2011).

The surplus of each trip is the difference between the actual travel cost and the maximum travel cost that road users would have been willing to tolerate represented by the demand curve "d1" in Figure 2. Road improvements decrease transport costs (from "COST1" to "COST2") and in turn increase in consumer surplus (yellow areas) associated with the following types of traffic (Deren 2011):

- Normal traffic: baseline traffic in the without project scenario (typically increases over time).
- Generated traffic: traffic generated due to a decrease in the generalized cost of travel; it is associated with existing users of a road driving more frequently or further than before.
- Diverted traffic: traffic generated due to a decrease in the generalized cost of travel; it is associated with travelers shifting to the project road from an alternative road with the same origin/destination.
- Induced traffic: traffic generated due to increased economic activity in the road's zone of influence brought about by the project that attracts travelers to the project road from other roads changing their origin or destination.

The changes in consumer surplus presented as yellow areas in Figure 2 are estimated as follows. In the case of normal traffic we only need to multiply the reduction in travel costs per trip by the number of baseline trips. For generated and diverted trips, however, we need to estimate how many additional users there will be with the improvement. Hence, we need to know the response of demand to the travel cost reduction associated with the road improvement - the elasticity of travel demand. Assuming a linear demand we approximate the triangular area of consumer surplus by multiplying the additional generated and diverted traffic by the change in transport cost and then by cutting it in half. Finally, we believe that induced traffic arising from new economic development associated with the road is largely unobserved in the initial traffic counts. We therefore quantify the consumer surplus in a base case without induced traffic and incorporate it in a series of sensitivity analysis scenarios using a range of magnitudes based on historical estimates of induced traffic quoted in the literature. The next two subsections describe the methodologies used to estimate transport costs (y-axis) and traffic volumes (x-axis), respectively.

Figure 2. Consumer Surplus Approach



Source: Deren 2011.

3.2.1 Unit Transport Cost

3.2.1.1 Travel Time Cost

The *hourly* cost of travel time per vehicle is calculated by multiplying the average number of persons in a vehicle by the hourly cost of time per person. The number of passengers traveling was obtained from origin destination surveys conducted by FIDEG in 2007 and 2010, before and after the project. An estimated cost of time of $1.35/hr was provided by MCC and is consistent with the parameters used by MCC for other road projects in the Central American Region. To provide some perspective, note that the average wage rate for all occupations in Nicaragua was approximately $1.78/hr in 2007 and decreased to $1.6 in 2010, both expressed in dollars of 2011.[4]

The *hourly* cost of travel time per vehicle is converted into a cost per vehicle per *kilometer* traveled ($/veh-km) using the estimated speed. MCC provided the equations for estimating speed as a function of road roughness for different combinations of road surface types (pavement, gravel, dirt) and terrain types (flat, rolling, mountainous). These equations had been estimated using the model HDM-4 developed by the World Bank. The current study uses ex-post information regarding the fleet composition to update the estimated speeds for the scenarios with and without project.

[4] A sensitivity analysis suggests that the ERR for the entire Transportation project would improve by approximately 0.70% if the cost of time used in the model had been $1.60 instead.

3.2.1.2 Vehicle Operating Cost

Vehicle operating cost (VOC) includes the cost of fuel, oil and lubricants, tires, maintenance, depreciation, and finance charges; and these depend on the type of vehicle. We use the most current costs for the region which were collected in Honduras in 2011, and provided by the MCC. The traffic composition by vehicle type is obtained from origin destination surveys conducted by FIDEG in 2007 and 2010, before and after the project.

MCC provided the equations for estimating VOC per vehicle per *kilometer* traveled ($/veh-km) as a function of the road roughness for different combinations of road surface types (pavement, gravel, dirt) and terrain types (flat, rolling, mountainous). These equations had been estimated using the model HDM-4 developed by the World Bank. The current study uses ex-post information regarding the fleet composition to update the estimated savings in VOC.

3.2.1.3 Accidents Cost

Road improvements may have safety impacts by changing the probability of an accident or by changing the damage of the accident (fatality, injury, property damage only).

Accidents cost are not included in the analysis because there are no updated estimates available of the number and costs of accidents in the area. This omission is not likely to have a substantial impact on the results of the analysis due to the nature of the project being the rehabilitation of an existing road. Accounting for safety impacts would have been more important if the project involved a new road or significant diverted traffic from other roads or modes with substantially different rates and severity of accidents. In any case, to the extent that safety impacts of the road improvements are positive, the analysis understates the project's potential contribution to well-being and provides a conservative ERR. However, it is not clear a priori the direction of the effect. Upgrades that include increased road smoothness, width, and improved drainage are likely to improve safety, while higher speeds may make accidents more likely and more severe.

3.3 Traffic Volumes Forecast

The consumer surplus resulting from the project depends not only on the decrease in unit transportation cost but also on the traffic volumes. This subsection describes the methodology used to develop traffic forecasts for normal, generated, diverted, and induced traffic over the eighteen year period of road operations.

3.3.1 Normal Traffic

The study explored different approaches for forecasting normal traffic based on three alternative explanatory variables: time trend, gross domestic product (GDP), and population. These are accepted approaches in the literature (Hudiel 2010; Ortuzar and Willumsen, 2011; and TRL and DFID, 2005; among others) and have been used in other road studies for Nicaragua (IDISA-CONDISA 2011; Roughton and HTSPE 2008).

Normal traffic levels were forecast by multiplying an estimated elasticity of traffic with respect to the explanatory variable times the expected growth rate in this variable. For example, an elasticity of traffic with respect to GDP of 2.5 would indicate that a 1 percent increase in GDP is expected to be *associated* with a 2.5 percent increase in traffic.

The elasticity is obtained from the estimated coefficient in a simple univariate logarithmic regression. These simple regressions are used to identify an *association* between traffic and other variables; they are not intended to establish causality or to estimate a fundamental model of travel behavior. The current analysis relied on these simple regressions as opposed to multivariate regressions or more sophisticated time series methods due to small sample size issues and other data limitations. For the purposes of the current analysis the mentioned approaches are sufficient and have the advantage of transparency and simplicity.

3.3.2 Generated Traffic

Generated traffic is the increase over the baseline traffic estimated by multiplying the user-elasticity of demand – percent increase in traffic per percent decrease in travel costs – times the change in travel costs with project versus the baseline situation without project. In Figure 2, above, the generated traffic is depicted in the left panel as the change in from ADT1 to ADT2.

Generated traffic is associated with existing users of the road driving more frequently or farther than before due to the reduction in transportation costs from the road improvements. Travelers might choose to travel on the project road to a more distant destination for some trips such as shopping, or they may take a trip that they previously avoided altogether.

The analysis assumes a long-term elasticity of traffic with respect to travel costs equal to 1.0 for all vehicle types based on evidence from other studies for Nicaragua (see Archondo-Callao et al. 2003). An adjustment factor is applied to the first three years of road operation to account for the fact that it takes time for travelers to become aware and to adjust their behavior to the existence of a newly improved road. The assumed short term elasticity is half the long term elasticity, therefore the adjustment factor is 0.5 (see DeCorla-Souza and Cohen 1999; AASHTO 2011, page 6-10).

3.3.3 Diverted Traffic

Diverted traffic corresponds to vehicles previously traveling on other roads with the same origin/destination that would shift to the project road when improved. The magnitude of diverted traffic depends on several factors, including travel time and cost of the project road compared to the alternative road. Where parallel routes exist, traffic will usually travel on the quickest and cheapest route. After shifting to the project road, diverted traffic in later years is usually forecast to grow at the same rate as the normal traffic.

Origin and destination surveys were carried out to provide data to estimate likely traffic diversions. Assignment of diverted traffic is normally done by an 'all-or nothing' method in which it is assumed that all vehicles that would save time or money by diverting would do so, and that all vehicles that would lose time or increase costs would not transfer.

In general terms, the current analysis follows the assumptions made during the feasibility studies regarding diverted traffic. In the cases where there are no alternative competing roads to the project's improved road, diverted traffic is assumed to be zero (road S9). Diverted traffic is also assumed to be zero if the project road was already the best alternative before the improvements and/or travel time and cost do not vary enough to divert a substantial volume of traffic from other roads (road S1). If there is some potential for diverted traffic but no readily available information to estimate it, the analysis adopts the assumption of zero diverted traffic for a conservative base case scenario and then conducts sensitivity analysis with various assumed magnitudes of traffic diversion based on evidence in the literature. This was the approach in the case of the Villanueva-Guasaule road (VG) since some traffic going to other Central American countries previously choosing other routes is likely to be diverted through Guasaule.

3.3.4 Induced Traffic

Induced traffic is the increase in traffic volume from new travel to or through the area that would not occur without the project. In contrast to generated and diverted traffic which are responses to lower travel costs and thus represented by movement along the demand curve (see Figure 2 left panel), induced traffic can be understood conceptually as an outward shift in demand which may be associated with changes in income or new economic development. An example is depicted in the right panel of Figure 2, above, as movement from ADT2 to ADT3. The construction of a new road could likely result in induced traffic by making new areas accessible. Road improvement activities, however, are less likely to create induced traffic than the creation of a new road access to a previously isolated area. Furthermore, the road improvement activities were completed in 2010 and it is likely that any economic development able to induce significant traffic would take longer to occur. As mentioned by one reviewer, the projects were more substantial than a simple road improvement and we recognize that some degree of induced traffic may have occurred. However, due to data limitations we adopt the conservative assumption of zero induced traffic and conduct a sensitivity analysis afterwards.

3.4 Beneficiary Analysis Methodology

The MCC classifies projects broadly into three categories: National and regional, broad-based, and targeted. The road infrastructure project fits in the broad-based category which is defined as "large-scale investments whose beneficiaries are typically counted as users of the new or improved public systems or those who will benefit from the use by others" (MCC 2009).

ERR is concerned with economic efficiency impacts from the perspective of society as a whole as represented by the aggregate of benefits and costs, as opposed to the distributional impacts which are the focus of the beneficiary analysis.

Vehicle counts combined with the HDM-IV model allow a reasonably accurate estimate of the number of vehicles expected to travel on the improved road. However, road projects are expected to benefit a wider set of individuals beyond those travelling on the roads themselves; as such, all households living within five kilometers of the improved roads are likely to benefit. Where available, a recent census or other survey dataset may therefore be useful in estimating the number of individuals who will benefit from a project (MCC 2009). For this evaluation, we consider a 5 km distance from the road to be the edge of the zone of influence.

4 Economic Rate of Return for the Road Leon-Poneloya-Las Peñitas (S-9)

This section re-estimates the economic rate of return after the completion of the construction activities for the road segment between Leon and Poneloya/Las Peñitas (S9). This section is organized in the following subsections: 1. Description of the project and area of influence; 2. Traffic forecast without-project (baseline) and with-project; 3. Results and sensitivity analysis.

4.1 Description of the Project and Area of Influence

The road S9 is located in the Department of León and is 19.6 km (12.2 miles) long, with 73 percent of it in flat terrain and 27 percent in hilly terrain. Before the project the road surface was pavement, the average running speed of vehicles was about 55 km/hr and the IRI was about 12 m/km, which indicates a very poor condition, especially for a paved road with its level of baseline traffic. The rehabilitation of S9 was performed on the existing route with no noticeable changes of its horizontal alignment. The project included the improvement of pavement structures, minor and major drainage structures, sidewalks, shoulders, signage, and buses bays.

The road S9 is located in the Municipio de León and connects the city of León with the fishing port of Poneloya and the coastal village of Las Peñitas. The road provides the only direct access to these coastal communities. Other communities directly served by the road include Carlos Canales, Guanacastillo, La Ceiba, La Gallina, Las Delicias, La Pedrera, San Roque, and Miramar. Along the road are several small schools, small health centers, and businesses (TYPSA-AZTEC 2008b).

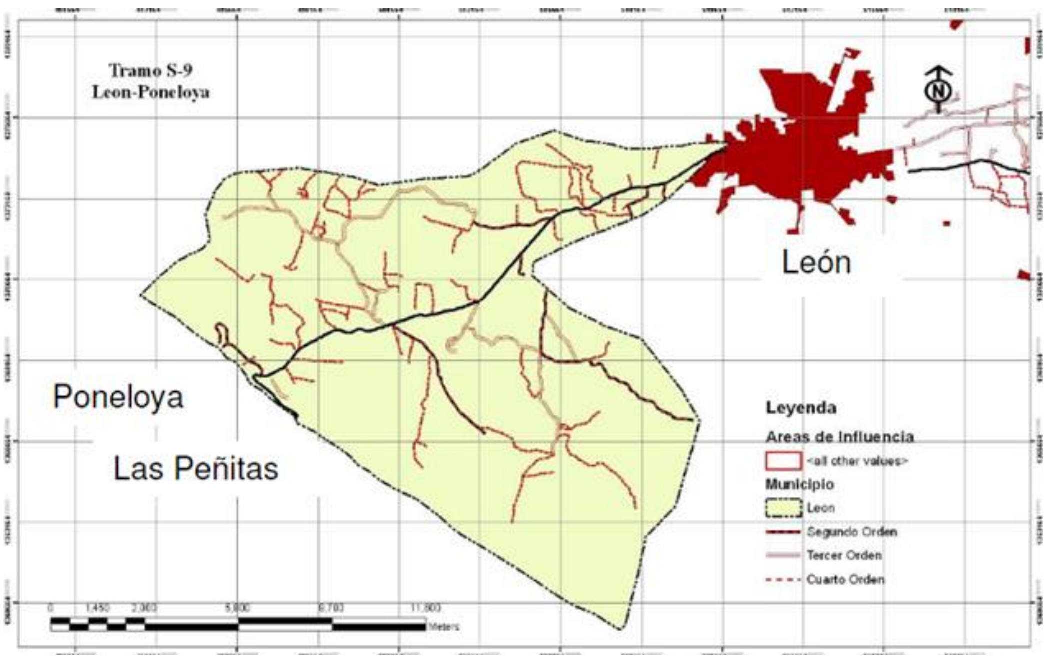
Figure 3 shows an area of 145 km^2 that are directly influenced by the network of roads related to S9, as defined in the feasibility study prepared by TYPSA-AZTEC (2008b). For purposes of the current analysis it is necessary to translate it into the corresponding sociopolitical area. After careful examination it was determined that the area of influence of S9 is well represented by all the barrios in León (since all are within approximately 5 kms from the road) and the five comarcas of El Obraje, Barzones, Poneloya/Las Peñitas, Goyena, and Trohilo (Table 3).

The socioeconomic characteristics in the area of influence of the project are shown in Table 3. For comparison purposes, the table presents the same information at more aggregated levels for the country, departamento, and municipio. According to the 2005 Census approximately 144,574 persons were living in the area of influence of S9. These intended beneficiaries represent 83 percent of the total population in the Municipio de León, 41 percent of the Departamento de León, and 3 percent of the country's total population.

Females represent about 53.2 percent of the affected population, higher than the 51.3 percent in Departamento de León (which in turn has one of the departmentos with the highest female presence in the country). The population of age 15 and more accounts for 69.5 percent, reflecting an older population than the average in the country (62.5 percent).

The area of influence has extreme poverty and general poverty incidence rates of 13.0 percent and 46.3 percent, respectively, which are slightly lower than the corresponding rates at the national and departmental levels. As shown in Table 3 however, the average rate masks a great heterogeneity in poverty conditions at a more disaggregated level. The general poverty incidence rate ranges from 45 to 70 percent and the extreme poverty rate ranges from 11.9 to 35.2 percent. Figure 4 shows that while poverty is low in the urban Barrios in León, it is either high or severe in all of the five comarcas included in the area of influence of the road S9.

Figure 3. Direct Influence Area of Road Segment S9



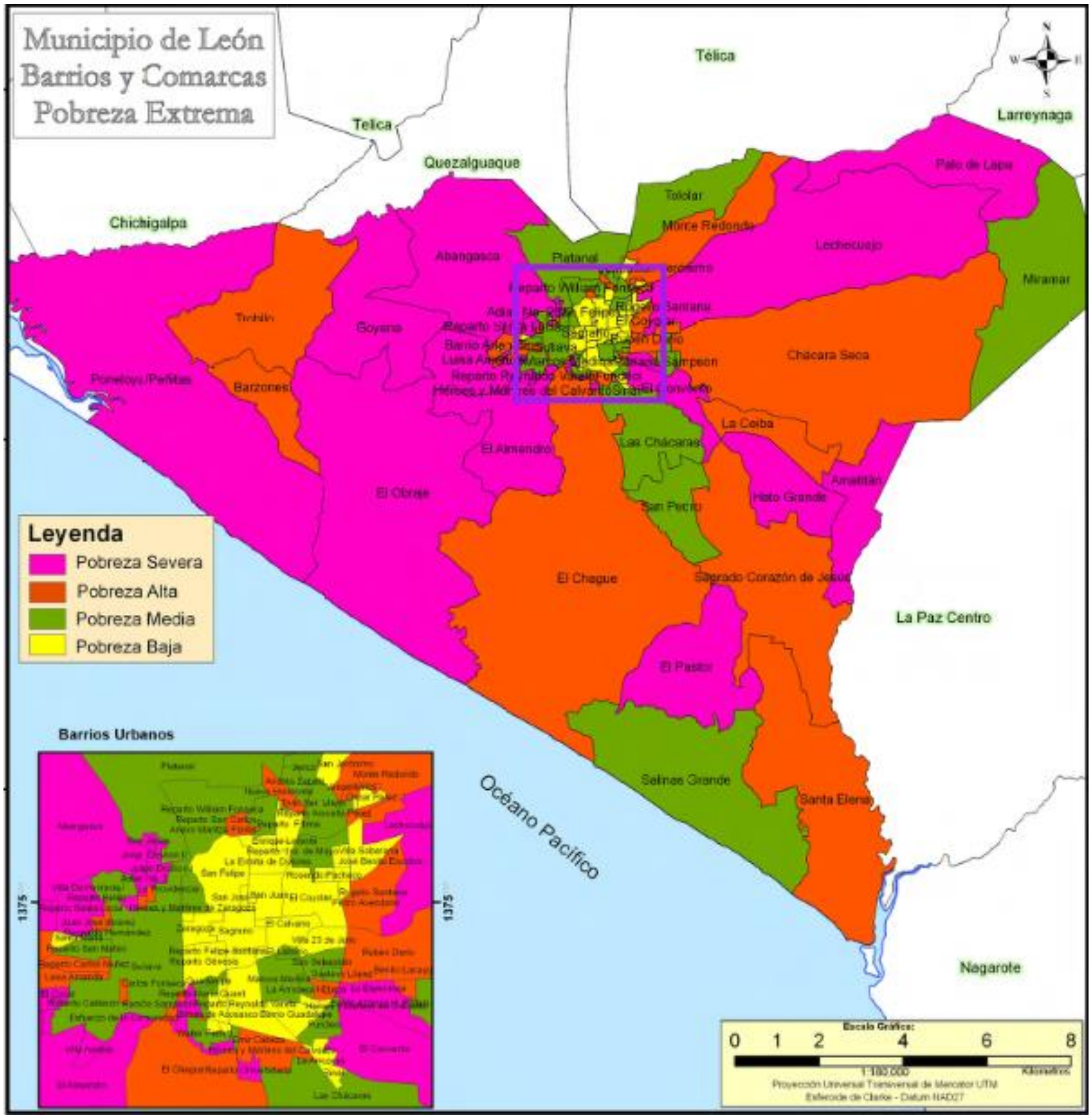
Source: TYPSA-AZTEC, 2008a

Table 3. Baseline Population for Road Segment S9

	Population Demographics (2005)			Poverty (%)	
	Total	Female (%)	Age 15+ (%)	Extreme	Total
NICARAGUA	5,142,098	50.7	62.5	15.0	48.3
Departamento de León	355,779	51.3	66.0	11.9	48.7
Municipio de León	174,051	52.6	68.4	19.5	50.2
Total Area of Influence	**144,574**	**53.2**	**69.5**	**13.0**	**46.3**
Barrios de León	137,429	53.5	69.9	11.9	45
Comarca El Obraje	1,707	48.3	61.2	35.2	67
Comarca Barzones	312	46.2	64.4	31.9	71
Comarca Poneloya/ Las Peñitas	2,797	47.3	61.7	33.5	69
Comarca Goyena	1,159	47.5	62.8	33.5	70
Comarca Trohilo	1,170	47.5	60.9	32.3	68
Outside Area of Direct Influence	29,477	49.5	63.2	51.5	69.6

Source: Own estimation based on INIDE, 2007.

Figure 4. Poverty Map, Municipio de León



Source: INIDE, 2007

4.2 Traffic Forecasts

4.2.1 Historic Traffic

Traffic counts were conducted by TYPSA-AZTEC before the project (2007) and by FIDEG in the first year with road improvements (2010) following the same methodology. Two stations were located near the road's termini: station#1 was located one kilometer outside the urban perimeter of Leon on the road towards Poneloya/Las Peñitas, and station#2 was located on the road's junction of Poneloya and Las Peñitas. Table 4 shows the annual average daily traffic (AADT) for the road calculated as the weighted average of both stations. The estimated AADT increased from 1,042 in 2007 to 1,462 in 2010, at a CAGR of 12 percent. The table also shows the composition of motorized traffic by vehicle type. Light passenger vehicles (motorcycle, car, pickup, jeep) increased their share from 83 percent of the traffic in 2007 to 87 percent in 2010. The share of buses (trucks) changed from 12 percent (4 percent) in 2007 to 6 percent (6 percent) in 2010.

Traffic counts at the two termini of the road S9 are not available for other years. Since more than two years of data are needed to develop traffic forecasts we use past trends in AADT from MTI (2012). These AADT correspond to the station 1401 located in NIC-14 at the junction of El Polvón and Poneloya/Las Peñitas, close to the project road, and are available back to 1999. Table 5 and Figure 5 show that the AADT estimated by MTI increased from 1,004 in 2007 to 1,289 in 2012, at a CAGR of 5.1 percent. The table also shows the composition of motorized traffic by vehicle type. About 81 percent in 2007 and 79 percent of the in 2012 traffic corresponds to light passenger vehicles (motorcycle, car, pickup, jeep). Buses accounted for 7 percent of total traffic in 2007 and 6 percent in 2012, while trucks represented 8 percent in both years. The category “other” includes trailers and heavy equipment vehicles for construction and agriculture.

The comparison of AADTs in Table 4 and Table 5 suggests that traffic trends from both sources are consistent. Depending on the specific road, MTI may or may not have a station close by that provides good enough traffic counts as proxy for the project’s road. Traffic counts performed at the road’s termini (or other locations ideal for the project’s purposes) are costly but are extremely valuable. They provide a benchmark to validate the publicly available series of AADT from MTI and/or make any necessary adjustments to it. It is recommended that projects develop their own traffic counts at least before and after construction, and ideally a few times after the construction so as to allow enough time for changes to be observed.

Table 4. Road S9 - Traffic Composition by Type of Vehicle, reported by FIDEG, 2007 and 2010

	PASSENGER VEHICLES						CARGO VEHICLES		Other	AADT
		Light Vehicles			Bus		Truck			
	Motorcycle	Car	Pickup	Jeep	Light	M&H	Light	M&H		
2010	347	427	335	167	29	64	84	3	4	1,460
2007	168	275	283	142	13	113	43	1	4	1,042

Source: FIDEG, 2011

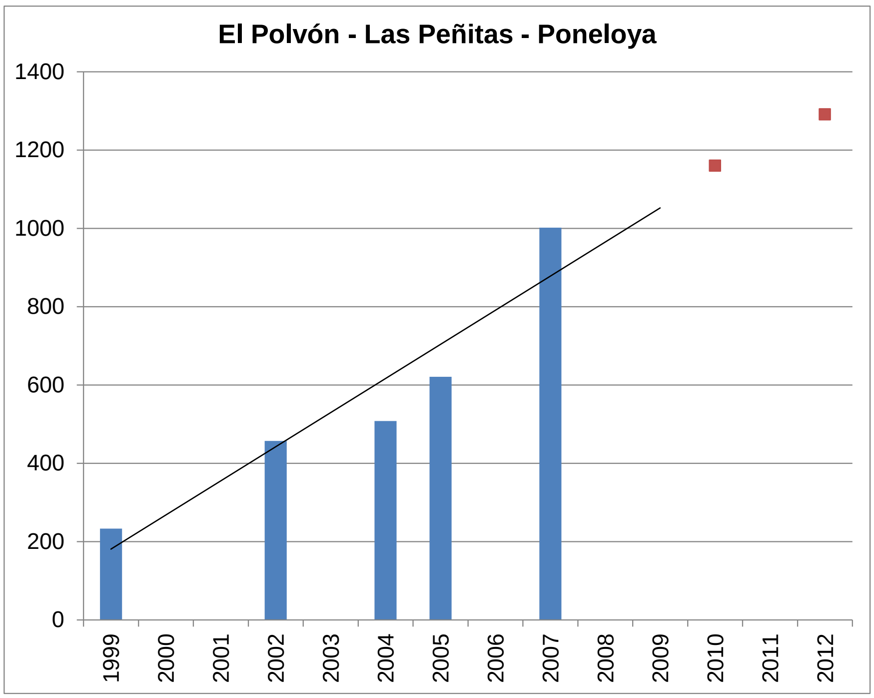
Table 5. Road S9 - Traffic Composition by Type of Vehicle, reported by MTI, 1999 to 2012

	PASSENGER VEHICLES						CARGO VEHICLES		Other	AADT
		Light Vehicles			Bus		Truck			
	Motorcycle	Car	Jeep	Pickup	Light	M&H	Light	M&H		
2012	218	267	141	393	34	46	75	34	81	1,289
2010	196	240	127	353	31	42	67	31	73	1,160
2007	71	192	136	411	20	50	55	30	39	1,004
2005	58	135	79	229	5	41	35	25	16	621
2004	28	112	72	188	10	35	31	22	10	508
2002	21	84	76	172	8	26	18	40	13	457
1999	9	44	20	85	7	32	13	21	0	233

Source: MTI, 2012

Figure 5 shows the evolution of AADT without project between 1999 and 2007 in blue bars and the AADT with project in 2010 and 2012 as red squares. The projection of the linear trend shows the AADT that would be expected in the situation without project, i.e. the normal traffic. Since the projected normal traffic is aligned with the AADT observed in 2010 and 2012, the figure suggests that the additional traffic resulting from the road improvement has been minor so far. Given the evidence from the literature review that it takes more than two years to see the full impacts of a road improvement in generated and induced traffic this trend is likely to constitute a lower bound on the final effects of the road.

Figure 5. Road S9 – Historic Traffic, 1999 to 2012



Source: Own estimates using MTI, 2012.

4.2.2 Forecast for Normal Traffic (Baseline)

Normal traffic volumes for a period of eighteen years are forecast under three alternative scenarios based on time trend, real GDP growth, and population growth. The scenarios based on GDP growth are preferred in the literature and in our case provide the median estimate of traffic growth. Preliminary tables provide comparisons across methods, however, only the preferred GDP based results are presented in detail below. In addition to the choice of scenario for growth rates, the choice of traffic count samples (permanent station vs. small roads) has an important impact on estimated results. The permanent station counts are more robust and so are used jointly with the GDP scenario in our detailed presentation of results.

Table 6 shows the elasticity of normal traffic with respect to each of the three variables, estimated using simple logarithmic regressions. The table also shows the assumptions used in the analysis regarding future growth rates in GDP and population. The elasticities of traffic with respect to time trend and with respect to population have proven relatively stable over the period for which data is available, with the 1999 Hurricane Mitch disaster a notable exception. The relationship between GDP and traffic changes has been less reliable, with traffic not falling as rapidly as GDP during some downturns. However, given the Central Bank forecast for stable GDP growth, choosing between GDP and the time trend in traffic growth makes little difference in the ERR calculations.

The annual growth rate in normal traffic under the "low" scenario is calculated by multiplying the population growth rate in Nicaragua times an elasticity of traffic with respect to population. The "medium growth" scenario uses the GDP growth rate for Nicaragua and the corresponding elasticity of traffic with respect to GDP. The "high growth" scenario directly uses the annual growth rate in normal traffic represented by the elasticity with respect to time. The resulting annual growth rates in normal traffic for the three scenarios are presented in Table 7.

Table 6. Time Trend, GDP, and Population Elasticities and Growth – Road S9

	Elasticity	2008-2012	2013-2017	2018-2022	2023-2027
Trend	3.62	-	-	-	-
GDP	0.88	4.00%	4.00%	4.00%	4.00%
Population	2.68	1.26%	1.15%	1.00%	0.87%

Source: Own estimates using MTI, 2012; BCN, 2011; and INIDE, 2007.

Table 7. Normal Traffic Growth Scenarios for S9

Growth Rate	2008-2012	2013-2017	2018-2022	2023-2027
Trend	3.62%	3.62%	3.62%	3.62%
GDP	3.53%	3.53%	3.53%	3.53%
Population	3.40%	3.08%	2.69%	2.34%

Source: Own estimates, based on Permanent Station traffic samples (MTI, 2012).

Applying the growth rates related to the GDP elasticity we obtain the forecasted annual traffic volumes presented as AADTs in Table 8. The table also shows the forecast of traffic by vehicle type maintaining the same composition observed without the project in 2007.

Table 8. Normal Traffic Forecast Baseline for S9

Year	Light Passenger Vehicles	Heavy Passenger Vehicles (Bus)	Cargo Vehicle (Truck)	Normal Traffic (AADT)
2008	814	110	128	**1,052**
2009	855	115	135	**1,105**
2010	826	111	130	**1,068**
2011	800	108	126	**1,034**
2012	773	104	122	**1,000**
2013	801	108	126	**1,035**
2014	829	112	131	**1,071**
2015	858	116	135	**1,109**
2016	889	120	140	**1,149**
2017	920	124	145	**1,189**

2018	952	128	150	**1,231**
2019	986	133	156	**1,275**
2020	1,021	138	161	**1,320**
2021	1,057	143	167	**1,366**
2022	1,094	148	173	**1,415**
2023	1,133	153	179	**1,465**
2024	1,173	158	185	**1,516**
2025	1,215	164	192	**1,570**
2026	1,258	170	198	**1,626**
2027	1,302	176	205	**1,683**

Source: Own estimates based on the mid-growth scenario (GDP growth) and Permanent Station traffic samples (MTI 2012).

4.2.1 Forecast for Generated and Induced Traffic (With Project)

Generated traffic is estimated by multiplying the user-elasticity of demand assumed to be equal to 1.0 by the percentage change in travel costs with the project relative to the no project baseline. A short-term adjustment factor is applied to the first three years of road operation (75%, 50%, and 25%) to account for the empirical evidence that the impact is not fully observed at once but rather increases gradually during the first few years. As stated in the feasibility, there is no competing route and thus no possibility of traffic diverting to the study road (TYPSA-AZTEC, 2008a). The induced traffic is assumed to be 3 percent of the normal traffic.[5] The results are shown in columns 3 and 4 of Table 9 for the GDP growth methodology using traffic counts from the relevant permanent station, as an example of the calculation results. Results for all methodologies are in the attached Excel file.

4.3 Life-cycle costs

The MCC provided information on costs incurred during construction and estimates of future maintenance expenditures. All costs were adjusted from nominal to real 2011 dollars using the average U.S. consumer price index. In terms of real 2011 dollars construction expenditures, inclusive of supervision, resettlement, monitoring, and evaluation costs were $21.2 million. Following standard practice, the residual value of the road is assumed as 10 percent of the initial construction cost.

The budgeted maintenance expenditures for the rehabilitated segment of S9 include annual routine maintenance costs for minor repairs estimated at $18,287 (i.e. $933 per km). Every six years, additional periodic maintenance costs estimated at $404,005 (i.e. $20,613per km) are included for major repairs. In contrast, under baseline conditions the annual routine maintenance costs are estimated at $110,570 (i.e. $5,641 per km) between 2010 and 2027. Additional periodic maintenance costs of $425,269 (i.e. $21,697 per km) are included every six years for major repairs. The cost savings are shown as agency benefits in columns 5 and 6 of Table 9.

[5] Changes in these assumptions were considered in a sensitivity analysis and do not change the conclusions regarding the expost ERR (see attached Excel file for details).

4.4 Results

Table 9 summarizes the results of the ex-post ERR analysis for the GDP methodology using permanent station sample of MTI traffic counts. Columns 2 – 4 show the normal, generated, and induced traffic forecasts. Columns 5 -6 present the agency benefits from savings in road investment and maintenance costs. Columns 7-10 show the user benefits from savings in vehicle operating costs and travel time costs. All annual benefits are undiscounted values expressed in terms of U.S. dollars in the same base year (i.e. "2011 dollars"). The last column summarizes the total net benefits (or net cost if the value is negative) for each year. The corresponding net present value calculated using two different discount rate and the ERR are shown at the bottom of the table. The ex-post ERR is equal to 0.95 percent which is below the required threshold according to MCC (2009), SNIP (2011a, 2011b), and OMB (2011) for programs with federal funding.

Table 9. Expost ERR and NPV – Road S9

Year	Normal Traffic (veh/day)	Generated Traffic (veh/day)	Induced Traffic (veh/day)	Agency Benefits (M$)		User Benefits (M$)				Total Net Benefits (M$)
				Investment Costs	Maintenance Costs	Normal Traffic		Generated Traffic		
						VOC	Time	VOC	Time	
2008	1,052	0	0	-4.843	0.000	0.000	0.000	0.000	0.000	-4.843
2009	1,105	0	0	-11.705	0.000	0.000	0.000	0.000	0.000	-11.705
2010	1,068	84	7	-4.695	0.000	0.414	0.424	0.018	0.018	-3.821
2011	1,034	174	15	0.000	0.092	0.440	0.451	0.040	0.041	1.066
2012	1,000	267	24	0.000	0.092	0.466	0.481	0.068	0.070	1.177
2013	1,035	393	25	0.000	0.092	0.528	0.556	0.107	0.112	1.395
2014	1,071	138	26	0.000	0.114	0.135	0.137	0.010	0.011	0.406
2015	1,109	217	27	0.000	0.092	0.235	0.228	0.026	0.025	0.605
2016	1,149	344	28	0.000	0.092	0.424	0.419	0.069	0.068	1.072
2017	1,189	382	29	0.000	0.092	0.483	0.483	0.083	0.083	1.225
2018	1,231	422	30	0.000	0.092	0.549	0.558	0.101	0.102	1.402
2019	1,275	466	31	0.000	0.092	0.623	0.644	0.121	0.125	1.606
2020	1,320	179	32	0.000	0.114	0.183	0.177	0.015	0.014	0.502
2021	1,366	350	33	0.000	0.092	0.418	0.400	0.059	0.056	1.025
2022	1,415	460	34	0.000	0.092	0.593	0.592	0.104	0.103	1.484
2023	1,465	523	35	0.000	0.092	0.700	0.719	0.134	0.137	1.783
2024	1,516	539	37	0.000	0.092	0.722	0.741	0.137	0.141	1.833
2025	1,570	222	38	0.000	0.092	0.235	0.219	0.019	0.018	0.584
2026	1,626	457	39	0.000	0.114	0.570	0.551	0.087	0.084	1.406
2027	1,683	585	41	2.124	0.092	0.785	0.802	0.146	0.149	4.099

Net Present Value discounted at 10% (million $)	-9.815
Economic Rate of Return (ERR)	**0.95%**

Source: Own estimates based on the GDP growth scenario and Permanent Station traffic samples (MTI 2012).

4.5 Sensitivity Analysis

Table 10 summarizes the results of the sensitivity analysis where the NPV of the road improvement project was re-estimated with the following modified assumptions.

- Schedule: The sensitivity scenario #1 assumes a delay of one year in the project schedule (postponing both benefits and costs one year compared to the base case scenario).
- Benefits: In the unfavorable scenario the benefits in each year are assumed to be 10 percent lower than in the base case (scenario #2). In the favorable scenario the benefits in each year are assumed to be 10 percent higher than in the base case (scenario #4).
- Costs: In the unfavorable scenario the costs in each year are assumed to be 20 percent higher than in the base case (scenario #3). In the favorable scenario the costs in each year are assumed to be 20 percent lower than in the base case (scenario #5).
- Costs and Benefits: The best case scenario combines a decrease of 20 percent in the costs and a 10 percent increase in the benefits compared to the base case (scenario #6). The worst case scenario combines a increase of 20 percent in the costs and a decrease of 10 percent in the benefits compared to the base case (scenario #7).

As shown in Table 10 none of the sensitivity scenarios result in the project meeting the ERR required by MCC, SNIP and OMB.

Table 10. Sensitivity for S9 (method based on GDP elasticity, permanent station)

	NPV (Net User Benefits) discounted at		ERR
	8.0%	10.0%	
Base Case	**($8,814,205)**	**($9,814,857)**	**0.95%**
Sensitivity Scenarios:			
1: Delay 1 year	($8,975,499)	($9,476,435)	-0.9%
2: Benefits -10%	($9,642,518)	($10,504,498)	0.1%
3: Costs 20%	($12,233,671)	($13,157,110)	-0.4%
4: Benefits 10%	($7,985,892)	($9,125,217)	1.7%
5: Costs -20%	($5,394,738)	($6,472,605)	2.8%
6: Best (Costs -20%, Benefits 10%)	($4,566,425)	($5,782,964)	3.7%
7: Worst (Costs 20%, Benefits -10%)	($13,061,984)	($13,846,751)	-1.2%

Source: Own estimates.

The previous table summarizes results from using the GDP elasticity to forecasts future traffic counts. For completeness, the next table summarizes the results for all three alternative methodologies: time trend, GDP, and population elasticity. Again, none of the sensitivity scenarios result in the project meeting the required ERR.

Table 11. Sensitivity for S9 (three methods, permanent station)

	ERR (Time Trend)	ERR (GDP)	ERR (Population)
Base Case	**0.99%**	**0.95%**	**0.56%**
Sensitivity Scenarios:			
1: Delay 1 year	-0.9%	-0.9%	-1.3%
2: Benefits -10%	0.2%	0.1%	-0.2%
3: Costs 20%	-0.4%	-0.4%	-0.8%
4: Benefits 10%	1.8%	1.7%	1.3%
5: Costs -20%	2.9%	2.8%	2.4%
6: Best (Costs -20%, Benefits 10%)	3.7%	3.7%	3.3%
7: Worst (Costs 20%, Benefits -10%)	-1.1%	-1.2%	-1.5%

Source: Own estimates.

The previous tables use the sample of historic traffic counts from MTI's closest permanent station. Our final sensitivity exercise consists of using a different sample of traffic counts. The next table summarizes the results of the analysis using a smaller sample of more sporadic and variable traffic counts on the individual road (for all three elasticity-based methods). Economic rates of return are significantly higher for this set of calculations but do not surpass the recommended 10% value for any of the three elasticity measures. The average ERR reported in the Executive Summary gives equal weight to the ERRs reported in Table 11 and Table 12. Note also that the monitoring and evaluation costs that were added on top of the construction costs were approximately 20% of total costs. However, it is MCC's policy to include those as relevant costs.

Table 12, Panel 1: Sensitivity for S9 (three methods, road sample)

	ERR (Time Trend)	ERR (GDP)	ERR (Population)
Base Case	**9.25%**	**8.49%**	**6.81%**
Sensitivity Scenarios:			
1: Delay 1 year	7.7%	7.0%	5.4%
2: Benefits -10%	8.3%	7.5%	5.9%
3: Costs 20%	7.6%	6.9%	5.2%
4: Benefits 10%	10.1%	9.4%	7.7%
5: Costs -20%	11.4%	10.6%	8.9%
6: Best (Costs -20%, Benefits 10%)	12.3%	11.6%	9.9%
7: Worst (Costs 20%, Benefits -10%)	6.7%	6.0%	4.3%

Source: Own estimates.

Table 11.1 and 12.1 provide results for all six combinations of methodologies and samples. The average across all of them is presented below in Table 12.2 and also in the Executive

Summary. For example, the ERR values of 0.99, 0.95,0.56, 9.25, 8.49, and 6.81 result in an average ERR of 4.5% as shown in Table 12.

Table 13, Panel 2: Summary of S9 Results (aggregated across methods and samples)

	S9
International Roughness Index	
IRI baseline	12.0
IRI end of compact	1.84
Annual Average Daily Traffic	
AADT baseline (2008)	1,052
AADT end of compact (2010)	1,160
AADT end of study period (2027)	6,986
Net Present Value	
NPV (10%, 2011 US$ mill.)	(6.35)
User benefits	10.36
Incremental costs	-16.71
Economic Rate of Return	
ERR (average across methodologies):	**4.5%**

5 Economic Rate of Return for the Road Somotillo-Cinco Pinos (S-1)

This section re-estimates the economic rate of return after the completion of the construction activities for the road segment between Somotillo and Cinco Pinos (S1). This section is organized in the following subsections: 1. Description of the project and area of influence; 2. Traffic forecast without-project (baseline) and with-project; 3. Results and sensitivity analysis.

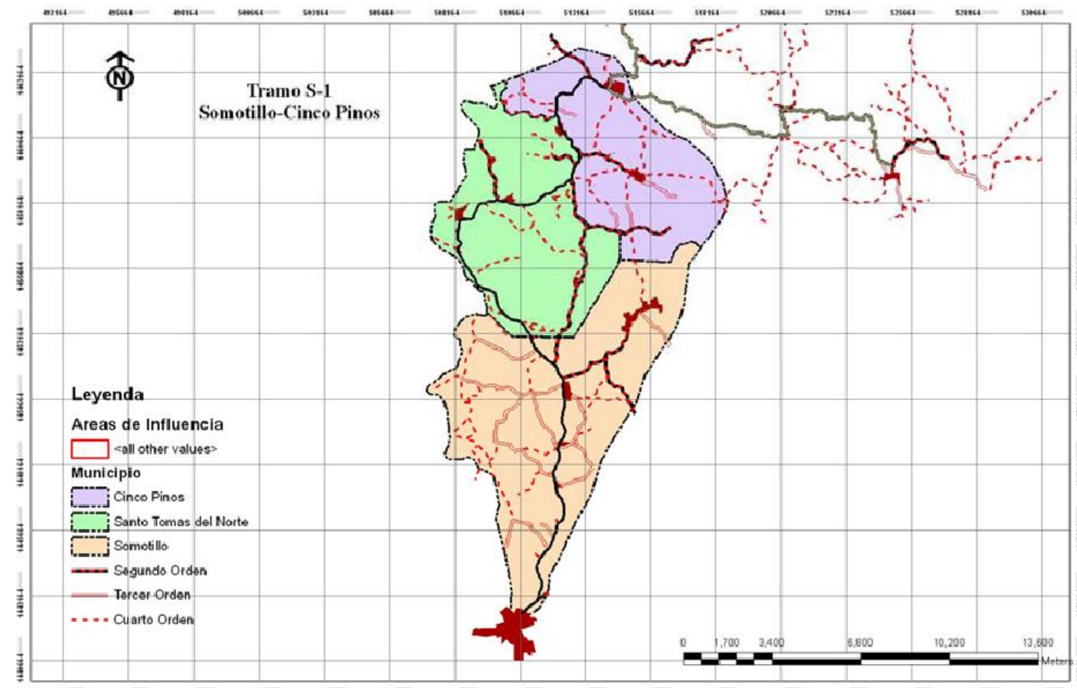
5.1 Description of the Project and Area of Influence

The road S1 is located in the Department of Chinandega and is 29.4 km (18.3 miles) long with generally flat terrain in the first 16.8 km and mountainous in the remaining 12.6 km. Before the project the wearing surface was gravel in good condition with an IRI varying between 8 to 10 which indicates a relatively good level of riding comfort for a rural road with its level of baseline traffic.

Figure 6 shows an area of 136 km^2 that are directly influenced by the network of roads related to S1, as defined in the feasibility study prepared by TYPSA-AZTEC (2008b). The purple area in the north represents part of the municipality of Cinco Pinos, the mid green area is the entire municipality of Santo Tomás del Norte and the southern pink area represents part of the municipality of Somotillo.

The road S1 is crosses the municipalities of Somotillo, Santo Tomás del Norte, and Cinco Pinos. The main communities served by the S1 road are Somotillo, Los Limones, Santo Tomás del Norte and Cinco Pinos. The road also crosses small communities such as Paso Hondo, Los Balcones, Santa Marta, La Uva, El Espino, El Zacatón, La Honda, Villa Camila, El Carrizal and La Pavana. Along the road there are several small schools of different academic levels, also small health centers and businesses (TYPSA-AZTEC 2008b).

Figure 6. Direct Influence Area of Road Segment S1



Source: TYPSA-AZTEC, 2008b

Table 14. Baseline Population for Road Segment S1

	Population Demographics (2005)			Poverty (%)	
	Total	Female (%)	Age 15+ (%)	Extreme	Total
NICARAGUA	5,142,098	50.7	62.5	15.0	48.3
Department of Chinandega	378,970	39.2	63.0	12.3	50.5
Total Area of Influence	**30,635**	**50.7**	**60.4**	**44.9**	**76.7**
Municipality of Cinco Pinos	6,781	49.7	61.6	41.1	74.5
Area of Influence–Cinco Pinos	5,932	49.7	61.8	40.2	74.0
Barrios Urbanos Cinco Pinos	1,192	51.2	67.4	46.3	81.2
Comarca La Honda	352	48.6	57.7	62.7	94.9
Comarca El Cerro	384	49.2	64.8	19.1	47.8
Comarca Maderas Negras	241	45.6	60.6	54.8	81.0
Comarca El Zacaton	733	49.9	59.3	36.7	63.9
Comarca Villa Francia	246	48.4	55.3	7.3	56.4
Comarca El Carrizal	203	49.3	65.0	22.7	63.6
Comarca El Espino	529	51.0	61.6	41.7	80.2
Comarca Las Tablas	191	52.4	58.6	42.4	87.9
Comarca Las Pozas	289	47.1	61.9	25.0	69.2
Comarca El Pavón	907	49.7	61.5	40.9	74.2
Comarca La Montaña	221	44.8	56.1	51.4	80.0
Comarca Las Lajitas	444	51.4	58.6	48.8	73.8
Outside Area of Influence	849	49.7	60.5	47.2	78.3
Municipality of Santo Tomas del Norte	7,124	49.8	59.2	47.4	80.5
Area of Influence- Sto Tomas del Norte	7,124	49.8	59.2	47.1	80.1
Barrios Urbanos Sto Tomas del Norte	1,229	50.9	61.8	63.6	97.6
Comarca Villa Carlos Ortega	496	50.8	54.4	35.4	63.7
Comarca Los Jovitos	865	50.8	55.3	51.9	87.2
Comarca El Granadino	463	50.5	54.2	53.0	91.0
Comarca La Uva	617	50.1	58.5	54.4	81.6
Comarca Ojo de Agua	886	50.8	61.2	35.2	62.4
Comarca Quebrada Arriba	395	46.8	65.3	38.4	68.5
Comarca Vado Ancho	787	50.1	62.4	38.4	79.0
Comarca Ceiba Herrada	339	46.0	55.8	39.7	84.1
Comarca Las Marias	566	49.8	58.3	48.7	77.9
Comarca Paso Hondo	481	45.7	60.1	39.3	71.4
Outside Area of Influence	-	-	-	-	-
Municipality of Somotillo	29,030	50.1	59.8	45.5	77.7
Area of Influence - Somotillo	17,579	51.5	60.4	45.6	76.3
Barrios Urbanos Somotillo	10,899	51.9	61.3	43.4	73.7
Comarca Los Limones	1,455	50.3	61.0	59.3	88.6
Comarca La Carreta	967	48.5	62.6	37.1	73.1
Comarca Los Encuentros	700	50.3	65.0	44.8	81.6
Comarca Jiñocuao	704	48.9	63.6	48.5	77.3
Comarca La Flor	1,299	56.2	48.0	52.5	83.3
Comarca Los Balcones	907	48.3	56.4	49.4	78.5
Comarca Santa Teresa	227	53.7	59.5	50.0	73.9
Comarca La Pavona	421	48.9	62.5	39.2	73.0
Outside Area of Influence	11,451	48.0	59.0	45.3	79.8

Source: Own estimation based on INIDE, 2007.

For purposes of the current analysis it was determined that the area of influence of S1 included 12 comarcas and all the urban barrios in Cinco Pinos; all the 10 comarcas and all the urban barrios in Santo Tomás del Norte; and 8 comarcas and all the urban barrios in Somotillo.

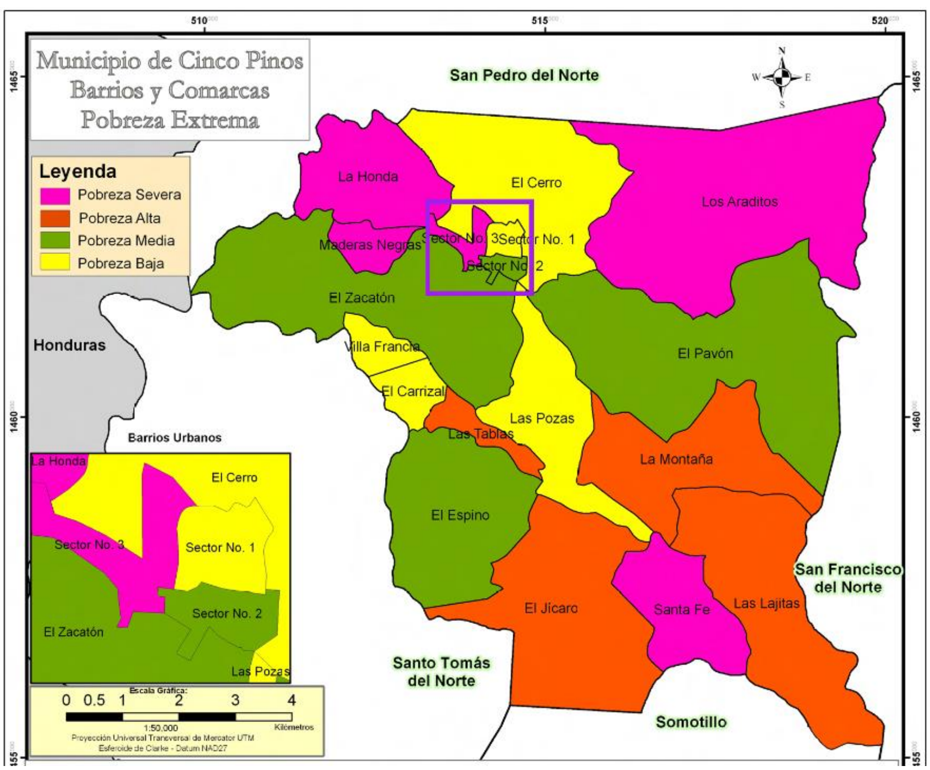
Table 14 shows the socioeconomic characteristics for the area of influence of S1, for the Department of Chinandega, and for Nicaragua. Based on information from the 2005 Census the estimated population in the area of influence of the road is approximately 30,635 persons. These intended beneficiaries represent 71 percent of the total population in the municipalities of Cinco Pinos, Santo Tomás de Norte, and Somotillo; 8 percent of the Department of Chinandega, and 1 percent of the country's total population.

Females represent about 50.7 percent of the affected population, same percentage as the national average. The population of age 15 and more accounts for 60.4 percent, reflecting a population somewhat younger than the national average (62.5).

The area of influence of S1 has an extreme poverty incidence rate of 44.9 percent, much higher than the national average of 15 percent, and has a general poverty rate of 76.7 percent which is also much higher than the national average of 48.3 percent. As shown in Table 14, there is only one community with a general poverty rate lower than the national average – comarca El Cerro and one with lower extreme poverty rate - comarca Villa Francia, both are located in the municipality of Cinco Pinos.

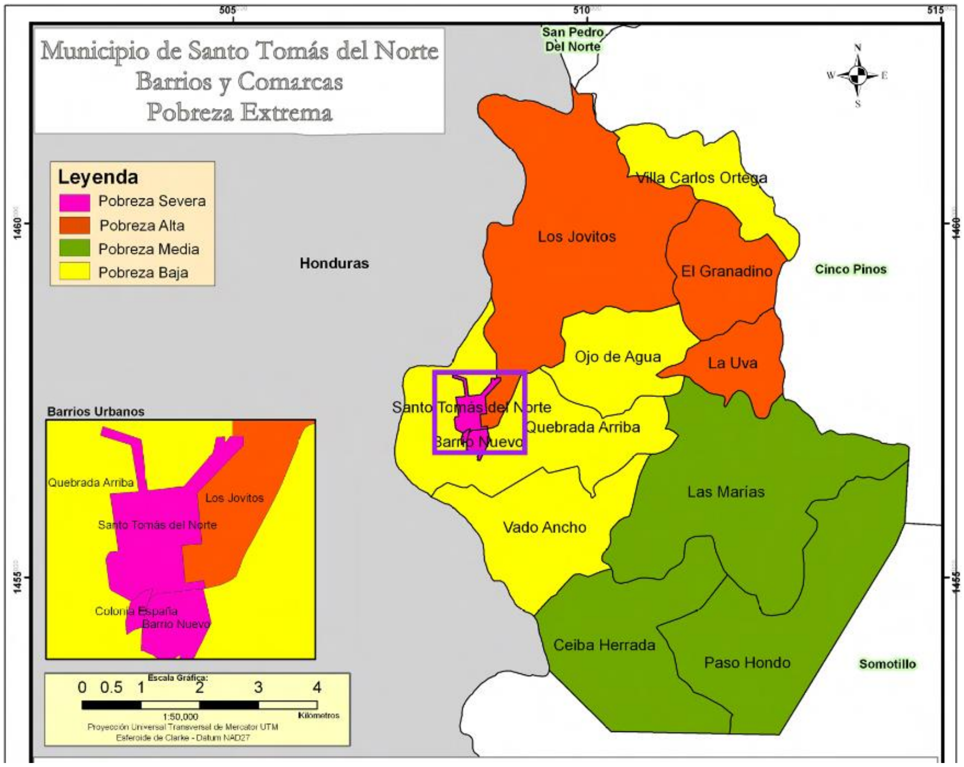
Figure 7 shows the poverty map for the Municipality of Cinco Pinos, Figure 8 for the Municipality of Santo Tomás del Norte, and Figure 9 for the Municipality of Somotillo.

Figure 7. Poverty Map, Municipality of Cinco Pinos



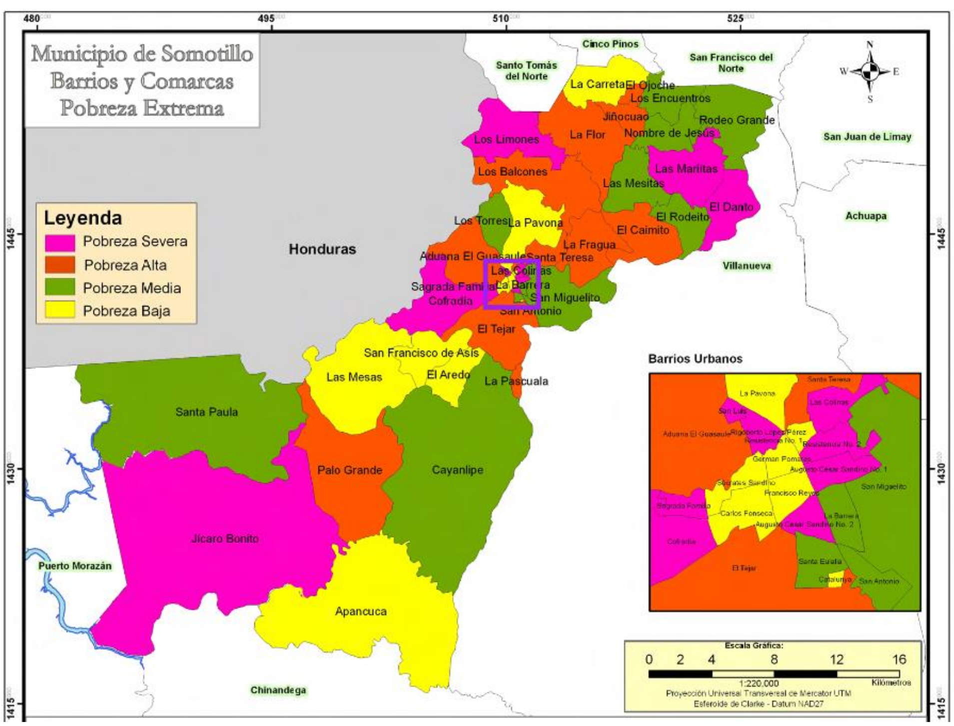
Source: INIDE, 2007

Figure 8. Poverty Map, Municipality of Santo Tomás del Norte



Source: INIDE, 2007

Figure 9. Poverty Map, Municipality of Somotillo



Source: INIDE, 2007

5.2 Traffic Forecasts

5.2.1 Historic Traffic

Traffic counts were conducted by TYPSA-AZTEC before the project (2007) and by FIDEG in the first year with road improvements (2010). Two stations provided traffic counts: station#1 was located between Somotillo and Santo Tomás del Norte, and station#2 was located between Santo Tomás del Norte and Cinco Pinos. Table 15 shows the annual average daily traffic (AADT) for the road calculated as the weighted average based on the length of both segments. The estimated AADT increased from 219 in 2007 to 561 in 2010, at a CAGR of 37 percent. The table also shows the composition of motorized traffic by vehicle type. Light passenger vehicles (motorcycle, car, pickup, jeep) increased their share from 75 percent of the traffic in 2007 to 80 percent in 2010. Buses decreased from 16 percent in 2007 to 7 percent in 2010, while trucks increased from 8 percent in 2007 to 13 percent in 2010. The category "other" includes trailers and heavy equipment vehicles for construction and agriculture. Traffic counts from FIDEG for S1 are not available for other years.

We obtained past trends in AADT from MTI (2012) for the station 3201 located in NIC-32B between Somotillo and Santo Tomás del Norte, on the project road.

Table **16** and Figure 10 show that the AADT estimated by MTI increased from 231 in 2009 to 415 in 2010, at a CAGR of 79.7 percent. The table also shows the composition of motorized traffic by vehicle type. About 76 percent in 2009 and 80 percent of the traffic in 2010 corresponds to light passenger vehicles (motorcycle, car, pickup, jeep). Buses (trucks) accounted for 13 percent (10 percent) of total traffic in 2009 and 7 percent (13 percent) in 2010. The comparison of AADT in Table 15 and Table 15 suggests that traffic trends from both sources are consistent.

Table 15. Road S1 - Traffic Composition by Type of Vehicle, reported by FIDEG, 2007 and 2010

	PASSENGER VEHICLES						CARGO VEHICLES		Other	AADT
		Light Vehicles			Bus		Truck			
	Motorcycle	Car	Pickup	Jeep	Light	M&H	Light	M&H		
2010	252	32	34	132	7	30	66	5	3	**561**
2009	49	21	79	14	6	28	17	1	3	**219**

Source: FIDEG, 2011

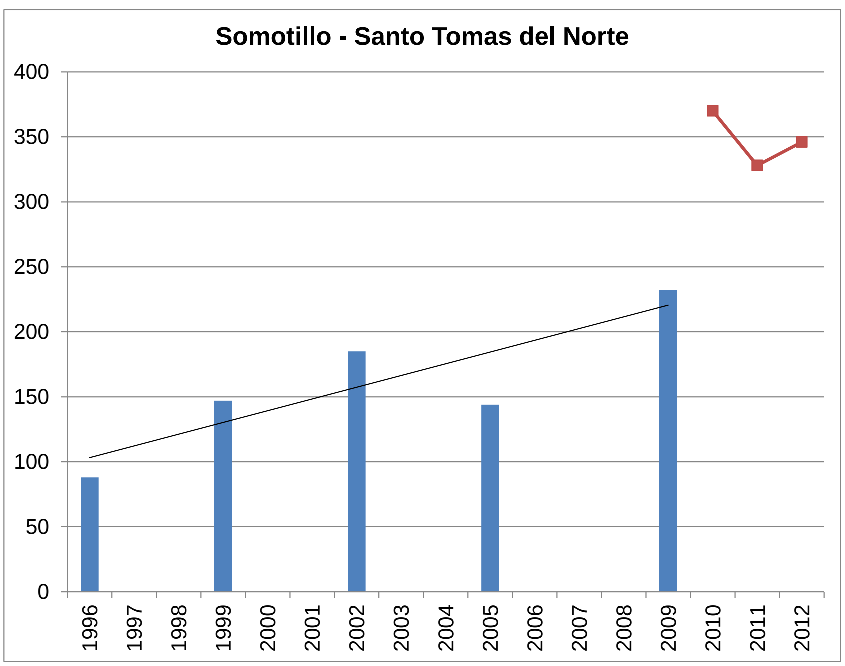
Table 16. Road S1 - Traffic Composition by Type of Vehicle, reported by MTI, 1996 to 2010

	PASSENGER VEHICLES						CARGO VEHICLES		Other	AADT
	Motorcycle	Light Vehicles			Bus		Truck			
		Car	Jeep	Pickup	Light	M&H	Light	M&H		
2012										
2010	192	26	19	94	6	24	45	8	1	415
2009	94	9	13	60	2	29	24	0	0	231
2005	28	2	7	59	2	24	21	1	0	144
2002	26	13	10	69	4	46	19	0	0	185
1999	15	4	15	60	0	29	24	0	0	147
1996	15	4	4	29	0	24	10	0	2	88

Source: MTI, 2012

Figure 10 shows the evolution of AADT between 1996 and 2009 (without project) in blue bars and the AADT in 2010 and 2012 (with project) as a red square mark. The projection of the linear trend shows the AADT that would be expected in the situation without project, i.e. the normal traffic. The AADT with project observed in 2010 is significantly higher and suggests that the road improvement has resulted in additional traffic.

Figure 10. Road S1 - Historic Traffic, 1996 to 2012



Source: Own estimates using MTI, 2012.

5.2.2 Forecast for Normal Traffic (Baseline)

Table 17 shows the elasticity of normal traffic with respect to time, real GDP, and population, estimated using simple logarithmic regressions. The table also shows the assumptions used in the analysis regarding future growth rates in GDP and population. The resulting annual growth rates in normal traffic are presented in Table 18. We believe that this is a conservative assumption considering the past trends in AADT for the road S1.

Table 17. Time Trend, GDP, and Population Elasticities and Growth - Road S1

	Elasticity	2008-2012	2013-2017	2018-2022	2023-2027
Trend	4.79	-	-	-	-
GDP	1.24	4.00%	4.00%	4.00%	4.00%
Population	3.50	1.26%	1.15%	1.00%	0.87%

Source: Own estimates using MTI, 2012; BCN, 2011; and INIDE, 2007.

Table 18. Normal Traffic Growth Scenarios for S1

Growth Rate	2008-2012	2013-2017	2018-2022	2023-2027
Trend	4.79%	4.79%	4.79%	4.79%
GDP	4.95%	4.95%	4.95%	4.95%
Population	4.43%	4.02%	3.50%	3.05%

Source: Own estimates, based on Permanent Station traffic samples (MTI, 2012).

Applying the growth rates related to the GDP elasticity we obtain the forecasted annual traffic volumes presented as AADTs in Table 19. The table also shows the forecast of traffic by vehicle type maintaining the same composition observed without the project in 2009.

Table 19. Normal Traffic Forecast (Baseline) for S1

Year	Light Passenger Vehicles	Heavy Passenger Vehicles (Bus)	Cargo Vehicle (Truck)	Normal Traffic (AADT)
2008	117	48	41	**206**
2009	132	55	46	**232**
2010	153	63	53	**269**
2011	134	56	47	**237**
2012	141	58	49	**248**
2013	147	61	51	**260**
2014	155	64	54	**273**
2015	162	67	56	**286**
2016	170	71	59	**301**
2017	179	74	62	**315**
2018	188	78	65	**331**
2019	197	82	69	**347**
2020	207	86	72	**365**
2021	217	90	75	**383**
2022	228	95	79	**402**
2023	239	99	83	**421**
2024	251	104	87	**442**
2025	263	109	92	**464**
2026	276	115	96	**487**
2027	290	120	101	**511**

Source: Own estimates, based on the mid-growth scenario (GDP growth) and Permanent Station traffic samples (MTI, 2012).

5.2.3 Forecast for Generated Traffic (With Project)

Generated traffic is estimated by multiplying the user-elasticity of demand assumed to be equal to 1.0 by the percentage change in travel costs with project versus situation without project. A short-term adjustment factor is applied to the first three years of road operation (75%, 50%, and 25%) to account for the empirical evidence that the impact is not fully observed at once but rather increases gradually during the first few years. Consistent with the feasibility study, the diverted and induced traffic are assumed to be zero.[6] “"Inasmuch as there is no route which could compete for traffic using this road, there is no possibility of diverted traffic over any significant length of the road." (TYPSA-AZTEC, 2008b). The results are shown in columns 3 and 4 of Table 20 for the GDP growth methodology using traffic counts from the relevant permanent station, as an example of the calculation results. Results for all methodologies are in the attached Excel file.

5.3 Life-cycle costs

MCC provided all the information regarding costs and the consultant adjusted nominal to real dollars using the average U.S. consumer price index. In terms of real dollars of 2011 the total initial expenditures (including construction, supervision, resettlement, monitoring, and evaluation costs) were $23.8 million. The residual value of the roadway in 2027 is estimated as 10 percent of the initial cost.

The rehabilitated segment S1 will require annual routine maintenance costs for minor repairs estimated at $27,383 (i.e. $933 per km). Every six years additional periodic maintenance costs estimated at $604,977 (i.e. $20,613 per km) are included for major repairs. In contrast, under baseline conditions the annual routine maintenance costs are estimated at $165,573 (i.e. $5,641 per km) between 2010 and 2027. Additional periodic maintenance costs of $636,818 (i.e. $21,697 per km) are included every six years for major repairs. The corresponding cost savings are shown as agency benefits in columns 5 and 6 of Table 20.

5.4 Results

Table 20 summarizes the results of the ex-post ERR analysis. Columns 2 - 4 show the normal, generated, and induced traffic forecasts. Columns 5 -6 present the agency benefits from savings in road investment and maintenance costs. Columns 7-10 show the user benefits from savings in vehicle operating costs and travel time costs. All annual benefits are undiscounted values expressed in terms of U.S. dollars in the same base year (e.g., “2011 dollars”). The last column summarizes the total net benefits (or net cost if the value is negative) for each year. The corresponding net present value calculated using two different discount rate and the ERR are shown at the bottom of the table. The ex-post ERR equal to -3.90 percent doesn’t meet the threshold required according to MCC (2009), SNIP (2011a, 2011b), and OMB (2011) for programs with federal funding.

[6] Changes in these assumptions were considered in a sensitivity analysis and do not change the conclusions regarding the expost ERR (see attached Excel file for details).

Table 20. Expost ERR and NPV – Road S1

Year	Normal Traffic (veh/day)	Generated Traffic (veh/day)	Induced Traffic (veh/day)	Agency Benefits (M$)		User Benefits (M$)				Total Net Benefits (M$)
				Investment Costs	Maintenance Costs	Normal Traffic		Generated Traffic		
						VOC	Time	VOC	Time	
2008	206	0	0	-4.751	0.000	0.000	0.000	0.000	0.000	-4.751
2009	232	0	0	-15.679	0.000	0.000	0.000	0.000	0.000	-15.679
2010	269	101	0	-3.326	0.000	0.322	0.187	0.060	0.035	-2.722
2011	237	91	0	0.000	0.138	0.298	0.179	0.057	0.035	0.707
2012	248	98	0	0.000	0.138	0.328	0.205	0.065	0.041	0.776
2013	260	108	0	0.000	0.138	0.369	0.239	0.077	0.050	0.872
2014	273	38	0	0.000	0.170	0.097	0.048	0.007	0.003	0.326
2015	286	60	0	0.000	0.138	0.168	0.083	0.018	0.009	0.415
2016	301	89	0	0.000	0.138	0.272	0.147	0.040	0.022	0.619
2017	315	102	0	0.000	0.138	0.320	0.182	0.052	0.029	0.722
2018	331	108	0	0.000	0.138	0.340	0.195	0.055	0.032	0.761
2019	347	112	0	0.000	0.138	0.356	0.205	0.058	0.033	0.790
2020	365	46	0	0.000	0.170	0.122	0.057	0.008	0.004	0.361
2021	383	91	0	0.000	0.138	0.272	0.140	0.032	0.017	0.599
2022	402	121	0	0.000	0.138	0.382	0.217	0.058	0.033	0.828
2023	421	137	0	0.000	0.138	0.442	0.263	0.072	0.043	0.958
2024	442	141	0	0.000	0.138	0.457	0.271	0.073	0.043	0.982
2025	464	145	0	0.000	0.138	0.469	0.278	0.073	0.043	1.002
2026	487	50	0	0.000	0.170	0.142	0.058	0.007	0.003	0.381
2027	511	117	0	2.376	0.138	0.364	0.190	0.042	0.022	3.131

Net Present Value discounted at 10% (million $)	-14.875
Economic Rate of Return (ERR)	**-3.90%**

Source: Own estimates, based on GDP growth scenario and Permanent Station traffic samples (MTI, 2012)..

5.5 Sensitivity Analysis

Table 21 summarizes the results of the sensitivity analysis where the NPV of the road improvement project was re-estimated for seven scenarios. These scenarios result from the following modified assumptions: delay of one year in the project schedule; increase/decrease in benefits of 10 percent; increase/decrease in costs of 20 percent; and the best and worst case scenarios resulting from the simultaneous changes in costs and benefits.

As shown in Table 22, under none of the scenarios considered in the sensitivity analysis would it meet SNIP's, OMB's, or MCC's required ERR.

Table 21. Sensitivity for S1 (method based on GDP elasticity, permanent station)

	NPV (Net User Benefits) discounted at		ERR
	8.0%	10.0%	
Base Case	**($14,553,956)**	**($14,874,704)**	**-3.9%**
Sensitivity Scenarios:			
1: Delay 1 year	($14,097,875)	($13,945,551)	-6.7%
2: Benefits -10%	($14,991,951)	($15,243,175)	-4.4%
3: Costs 20%	($18,340,738)	($18,586,587)	-4.7%
4: Benefits 10%	($14,115,960)	($14,506,232)	-3.4%
5: Costs -20%	($10,767,173)	($11,162,820)	-2.7%
6: Best (Costs -20%, Benefits 10%)	($10,329,177)	($10,794,349)	-2.2%
7: Worst (Costs 20%, Benefits -10%)	($18,778,734)	($18,955,059)	-5.2%

Source: Own estimates.

The previous table summarizes results from using the GDP elasticity to forecasts future traffic counts. For completeness, the next table summarizes the results for all three alternative methodologies: time trend, GDP, and population elasticity.

Table 22. Sensitivity for S1 (three methods, permanent station)

	ERR (Time Trend)	ERR (GDP)	ERR (Population)
Base Case	**-4.0%**	**-3.9%**	**-4.4%**
Sensitivity Scenarios:			
1: Delay 1 year	-6.8%	-6.7%	-7.3%
2: Benefits -10%	-4.5%	-4.4%	-4.8%
3: Costs 20%	-4.8%	-4.7%	-5.2%
4: Benefits 10%	-3.5%	-3.4%	-3.9%
5: Costs -20%	-2.8%	-2.7%	-3.2%
6: Best (Costs -20%, Benefits 10%)	-2.2%	-2.2%	-2.7%
7: Worst (Costs 20%, Benefits -10%)	-5.2%	-5.2%	-5.6%

Source: Own estimates.

The previous tables use the sample of historic traffic counts from MTI's closest permanent station. Our final sensitivity exercise consists of using a different sample of traffic counts. The next table summarizes the results of the analysis using a smaller sample of more sporadic and variable traffic counts on the individual road (for all three elasticity-based methods of time trend, GDP, and population, respectively. Conclusions about the ERR of the S1 road are not sensitive to the alternative traffic count methodologies.

Table 23, Panel 1. Sensitivity for S1 (three methods, road sample)

	ERR (Time Trend)	ERR (GDP)	ERR (Population)
Base Case	**-3.5%**	**-3.4%**	**-4.1%**
Sensitivity Scenarios:			
1: Delay 1 year	-6.1%	-6.0%	-6.9%
2: Benefits -10%	-4.0%	-3.9%	-4.6%
3: Costs 20%	-4.4%	-4.3%	-4.9%
4: Benefits 10%	-3.0%	-2.9%	-3.6%
5: Costs -20%	-2.3%	-2.2%	-2.9%
6: Best (Costs -20%, Benefits 10%)	-1.7%	-1.6%	-2.3%
7: Worst (Costs 20%, Benefits -10%)	-4.8%	-4.8%	-5.3%

Source: Own estimates.

Table 21 and 22.1 provide results for all six combinations of methodologies and samples. The average across all of them is presented below in Table 22.2 and also in the Executive Summary. For example, the ERR values of -4.0, -3.9,-4.4, -3.5, -3.4, and -4.1 result in an average ERR of -3.9% as shown in Table 22.2.

Table 22, Panel 2. Summary of S1 Results (aggregated across methods and samples)

	S1
International Roughness Index	
IRI baseline	13.2
IRI end of compact	3.38
Annual Average Daily Traffic	
AADT baseline (2008)	206
AADT end of compact (2010)	370
AADT end of study period (2027)	635
Net Present Value	
NPV (10%, 2011 US$ mill.)	(14.85)
User benefits	3.71
Incremental costs	-18.56
Economic Rate of Return	
ERR (average across methodologies):	**-3.9%**

6 Economic Rate of Return for the Road Villanueva - Guasaule

This section re-estimates the economic rate of return after the completion of the construction activities for the road segment between Villanueva and Guasaule (VG). This section is organized in the following subsections: 1. Description of the project and area of influence; 2. Traffic forecast without-project (baseline) and with-project; 3. Results and sensitivity analysis.

6.1 Description of the Project and Area of Influence

The road VG is located in the Department of Chinandega and is a flat pavement of 18 km (11.2 miles) long. Before the project the average running speed of vehicles was about 56 km/hr and the IRI was about 12 m/km, which indicates a road in very poor conditions for a paved road with its level of baseline traffic and international importance.

Roche (2008) defined the area of influence of the project as the municipality of Villanueva and Somotillo, plus parts of the watershed areas of the rivers Negro, Villanueva, and Estero Real.

For purposes of the current analysis it was determined that the area of influence of VG in the Municipality of Somotillo includes the comarca Aduana El Guasaule plus 17 other comarcas and all the urban barrios of the city of Somotillo; plus all the urban barrios in the city of Villanueva and 8 comarcas in the Municipality of Villanueva.

Table 24 shows the socioeconomic characteristics for the area of influence of VG, for the Department of Chinandega, and for Nicaragua. Based on information from the 2005 Census the estimated population in the area of influence of the road is approximately 34,453 persons. These intended beneficiaries represent 63 percent of the total population in the municipalities of Somotillo and Villanueva; 9 percent of the Department of Chinandega, and 1 percent of the country's total population.

Females represent about 50.3 percent of the affected population, practically the same as the national average of 50.7. The population of age 15 and more accounts for 59.0 percent, reflecting a population somewhat younger than the national average (62.5).

The area of influence of S1 has an extreme poverty incidence rate of 47.4 percent, much higher than the national average of 15 percent, and has a general poverty rate of 79.4 percent which is also much higher than the national average of 48.3 percent. As shown in Table 24

Table 24, the comarcas of El Aredo, Las Mesas, and San Francisco de Asis have noticeably lower poverty rates than the rest of the communities in the area of influence, however they are still poorer than the national average.

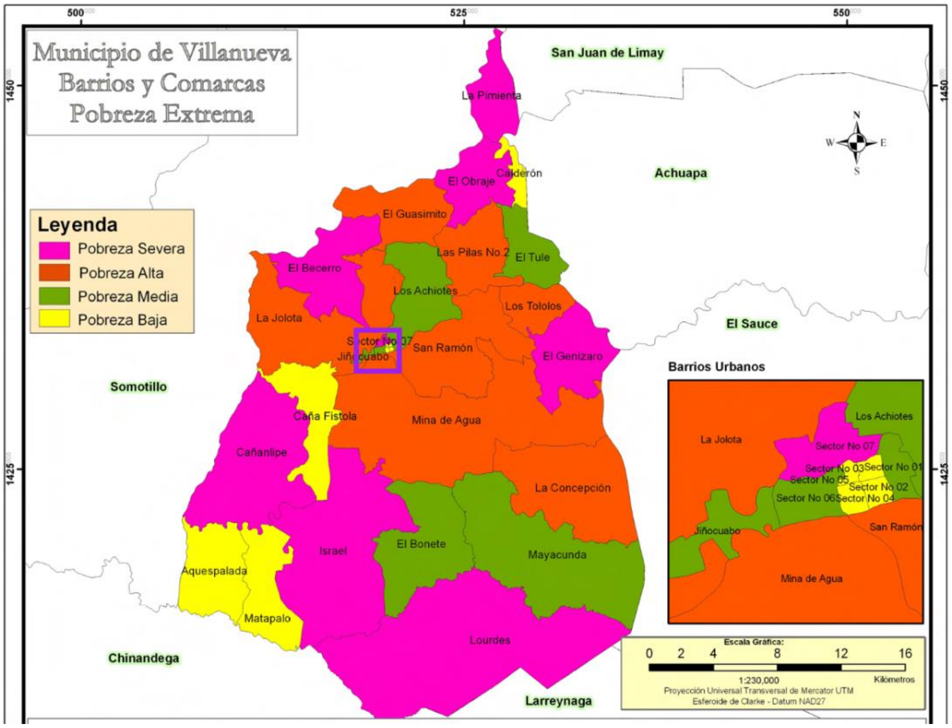
Figure 11 shows the poverty map for the Municipality of Villanueva, and Figure 12 for the Municipality of Somotillo.

Table 24. Baseline Population for Road Segment VG

	Population Demographics (2005 Census)			Poverty	
	Total	Female (%)	Age 15+ (%)	Extreme Poor (%)	Total Poor (%)
NICARAGUA	5,142,098	50.7	62.5	15.0	48.3
Department de Chinandega	378,970	39.2	63.0	12.3	50.5
Total Area of Influence of VG	**34,453**	**50.3**	**59.0**	**47.4**	**79.4**
Municipality of Somotillo	29,030	50.1	59.8	45.5	77.7
Area of Influence - Somotillo	18,576	50.8	60.1	44.3	76.6
Barrios Urbanos de Somotillo	10,899	51.9	61.3	43.4	73.7
Comarca Aduana El Guasaule	721	52.1	58.1	48.7	78.7
Comarca Los Torres	149	45.0	54.4	46.4	82.1
Comarca La Pavona	421	48.9	62.5	39.2	73.0
Comarca La Fragua	492	46.7	59.3	50.0	84.9
Comarca Santa Teresa	227	53.7	59.5	50.0	73.9
Comarca San Miguelito	581	48.0	50.9	47.0	89.0
Comarca El Tejar	577	48.2	55.1	48.1	81.1
Comarca Cofradia	266	49.2	57.1	60.3	87.3
Comarca San Francisco de Asis	234	48.7	60.3	25.0	73.1
Comarca El Aredo	268	48.9	52.2	22.0	66.0
Comarca La Pascuala	178	44.4	56.2	48.6	97.2
Comarca Las Mesas	413	50.8	59.8	24.4	63.9
Comarca Cayanlipe	307	46.3	57.0	40.6	72.5
Comarca Palo Grande	1,407	50.4	61.3	49.3	82.6
Comarca El Danto	212	50.9	56.6	62.2	91.9
Comarca Las Mesitas	446	48.9	58.1	47.0	84.3
Comarca El Rodeito	382	50.0	64.1	42.1	82.9
Comarca El Caimito	396	48.0	59.3	55.4	86.5
Outside Area of Influence	10,454	48.9	59.3	47.6	79.6
Municipality of Villanueva	25,660	49.0	57.6	51.4	82.2
Area of Influence - Villanueva	15,877	49.7	57.6	51.0	82.6
Barrios de Urbanos de Villanueva	4,591	51.7	63.0	43.4	78.1
Comarca El Becerro	2,332	48.1	52.6	65.7	93.6
Comarca La Jolota	1,238	49.2	57.4	57.5	82.6
Comarca Caña Fistola	2,025	49.7	54.5	38.6	74.5
Comarca El Guasimito	822	48.7	60.5	54.5	85.6
Comarca Los Achiotes	586	50.0	58.9	46.8	85.3
Comarca San Ramon	1,041	51.0	55.5	50.0	80.2
Comarca Mina de Agua	1,536	48.2	55.3	52.9	84.9
Comarca Cañanlipe	1,706	47.3	55.5	59.8	86.2
Outside Area of Influence	9,783	47.9	57.6	52.1	81.6

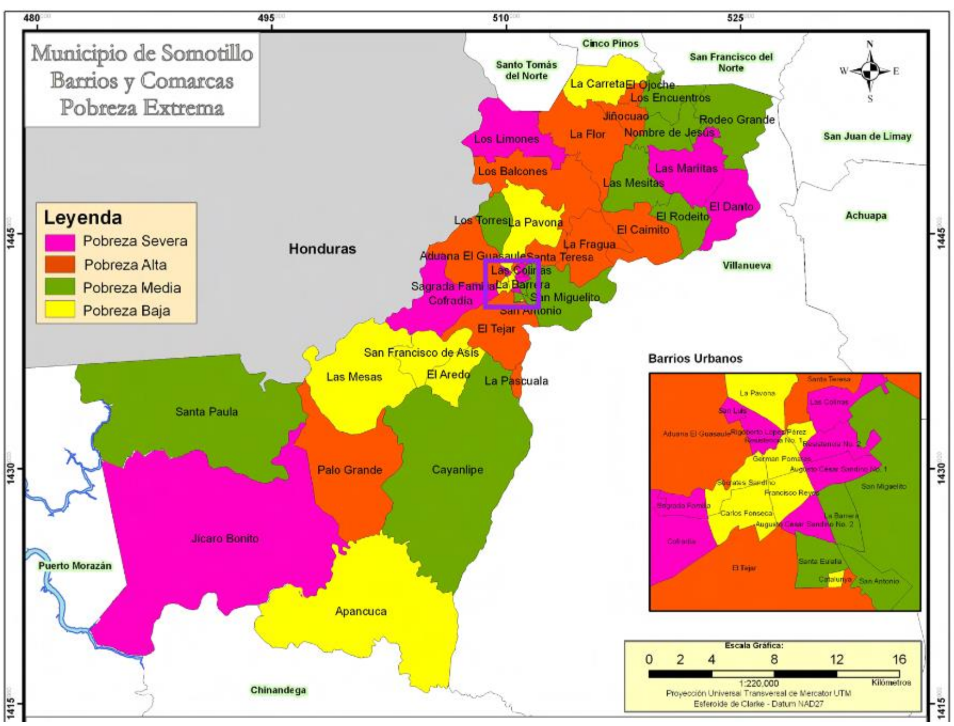
Source: Own estimation based on INIDE, 2007.

Figure 11. Poverty Map, Municipality of Villanueva



Source: INIDE, 2007

Figure 12. Poverty Map, Municipality of Somotillo



Source: INIDE, 2007

6.2 Traffic Forecasts

6.2.1 Historic Traffic

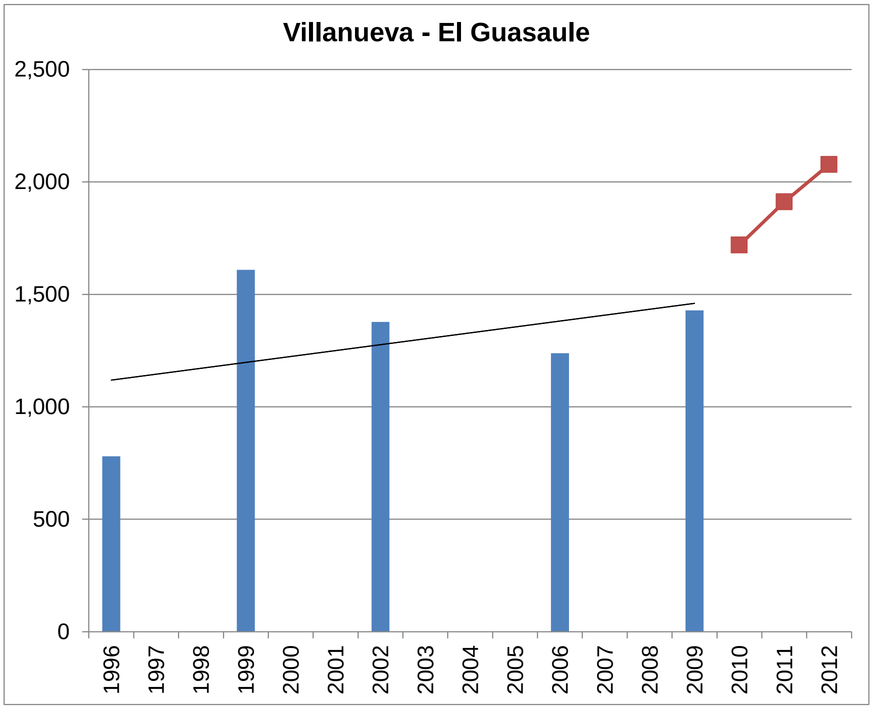
We obtained past trends in AADT from MTI (2012) for station 2406 in NIC-24B between Villanueva and Somotillo, and station 2403 in NIC-24B between Somotillo and El Guasaule. We calculated a weighted average based on the length of the two road segments. Table 25 and Figure 13 show that the AADT increased from 138 in 2009 to 322 in 2010, at a CAGR of 44.7 percent. The table also shows the composition of motorized traffic by vehicle type. About 68 percent in 2009 and 77 percent of the traffic in 2010 corresponds to light passenger vehicles (motorcycle, car, pickup, jeep). Buses accounted for 6 percent of total traffic in 2009 and 5 percent in 2010. Trucks accounted for 17 percent of total traffic in 2009 and 13 percent in 2010.

Table 25. Road VG - Traffic Composition by Type of Vehicle, reported by MTI, 1996 to 2010

	PASSENGER VEHICLES						CARGO VEHICLES			AADT
		Light Vehicles			Bus		Truck			
	Motorcycle	Car	Jeep	Pickup	Light	M&H	Light	M&H	Other	
2010	322	380	98	312	76	2	104	88	65	**1,447**
2009	138	235	54	254	61	3	87	82	86	**1,000**
2006	77	289	53	182	44	0	94	37	70	846
2002	32	399	65	219	72	2	100	39	76	1,004
1999	43	243	84	267	103	0	95	53	122	1,010
1996	26	64	64	198	3	21	84	26	71	555

Source: MTI, 2012

Figure 13. Road VG - Regression Model for Time Trend in Traffic, 1996 to 2012



Source: Own estimates using MTI, 2012.

6.2.2 Forecast for Normal Traffic (Baseline)

Normal traffic volumes for a period of eighteen years are forecast under three alternative scenarios based on time trend, real GDP, and population. Table 26 shows the elasticity of normal traffic with respect to each, estimated using simple logarithmic regressions, as well as the assumptions regarding their growth rates. The resulting annual growth rates in normal traffic are presented in Table 27. Table 28 shows the forecast of traffic by vehicle type maintaining the composition observed in 2009.

Table 26. Time Trend, GDP, and Population Elasticities and Growth - Road VG

	Elasticity	2008-2012	2013-2017	2018-2022	2023-2027
Trend	4.79	-	-	-	-
GDP	1.24	4.00%	4.00%	4.00%	4.00%
Population	3.50	1.26%	1.15%	1.00%	0.87%

Source: Own estimates using MTI, 2012; BCN, 2011; and INIDE, 2007.

Table 27. Normal Traffic Growth Scenarios for VG

Growth Rate	2008-2012	2013-2017	2018-2022	2023-2027
Trend	4.79%	4.79%	4.79%	4.79%
GDP	4.95%	4.95%	4.95%	4.95%
Population	4.43%	4.02%	3.50%	3.05%

Source: Own estimates, based on Permanent Station traffic samples (MTI, 2012).

Table 28. Normal Traffic Forecast (Baseline) for VG

Year	Light Passenger Vehicles	Heavy Passenger Vehicles (Bus)	Cargo Vehicle (Truck)	Normal Traffic (AADT)
2008	840	153	455	**1,448**
2009	840	153	455	**1,448**
2010	833	152	452	**1,437**
2011	910	166	493	**1,569**
2012	918	167	498	**1,584**
2013	964	176	522	**1,662**
2014	1,011	184	548	**1,744**
2015	1,062	194	575	**1,831**
2016	1,114	203	604	**1,921**
2017	1,169	213	634	**2,016**
2018	1,227	224	665	**2,116**
2019	1,288	235	698	**2,221**
2020	1,352	246	733	**2,331**
2021	1,418	259	769	**2,446**
2022	1,489	271	807	**2,567**
2023	1,562	285	847	**2,694**
2024	1,640	299	889	**2,828**
2025	1,721	314	933	**2,968**
2026	1,806	329	979	**3,114**
2027	1,895	346	1,028	**3,269**

Source: Own estimates, based on the mid-growth scenario (GDP growth) and Permanent Station traffic samples (MTI, 2012)

6.2.3 Forecast for Generated Traffic (With Project)

Generated traffic is estimated by multiplying the user-elasticity of demand assumed to be equal to 1.0 by the percentage change in travel costs with project versus situation without project. A short-term adjustment factor is applied to the first three years of road operation (75%, 50%, and 25%) to account for the empirical evidence that the impact is not fully observed at once but rather increases gradually during the first few years. Consistent with the feasibility study, the diverted and induced traffic are assumed to be zero.[7] The results are shown in columns 3 and 4 of Table 29 for the GDP growth methodology using traffic counts from the relevant permanent station.

6.3 Life-cycle costs

MCC provided all the information regarding costs and the consultant adjusted nominal to real dollars using the average U.S. consumer price index. In terms of real dollars of 2011 the total initial expenditures (including construction, supervision, resettlement, monitoring, and evaluation costs) were $20.7 million. The residual value of the roadway in 2027 is estimated as 10 percent of the initial costs.

[7] Changes in these assumptions were considered in a sensitivity analysis and do not change the conclusions regarding the expost ERR (see attached Excel file for details).

Annual (incremental) savings in maintenance costs from the VG rehabilitation project compared to the baseline are estimated at $84,750, except every six years when periodic maintenance is required and the savings are estimated at $104,278. The cost savings are shown as agency benefits in columns 5 and 6 of Table 29.

6.4 Results and Sensitivity Analysis

Table 29 summarizes the results of the ex-post ERR analysis. Columns 2 - 4 show the normal, generated, and induced traffic forecasts. Columns 5 -6 present the agency benefits from savings in road investment and maintenance costs. Columns 7-10 show the user benefits from savings in vehicle operating costs and travel time costs. All annual benefits are undiscounted values expressed in terms of U.S. dollars in the same base year (e.g., "2011 dollars"). The last column summarizes the total net benefits (or net cost if the value is negative) for each year. The corresponding net present value calculated using two different discount rates and the ERR are shown at the bottom of the table. The ex-post ERR equal to 4.71 percent doesn't meet the threshold required according to MCC (2009), SNIP (2011a, 2011b), and OMB (2011) for programs with federal funding

Table 29. Expost ERR and NPV for VG

Year	Normal Traffic (veh/day)	Generated Traffic (veh/day)	Induced Traffic (veh/day)	Agency Benefits (M$)		User Benefits (M$)				Total Net Benefits (M$)
				Investment Costs	Maintenance Costs	Normal Traffic		Generated Traffic		
						VOC	Time	VOC	Time	
2008	1,448	0	0	-3.584	0.000	0.000	0.000	0.000	0.000	-3.584
2009	1,448	0	0	-14.502	0.000	0.000	0.000	0.000	0.000	-14.502
2010	1,437	95	0	-2.631	0.000	0.551	0.427	0.018	0.014	-1.621
2011	1,569	223	0	0.000	0.085	0.670	0.516	0.048	0.037	1.356
2012	1,584	364	0	0.000	0.085	0.752	0.580	0.087	0.067	1.569
2013	1,662	548	0	0.000	0.085	0.874	0.677	0.144	0.112	1.892
2014	1,744	177	0	0.000	0.104	0.192	0.184	0.010	0.009	0.499
2015	1,831	293	0	0.000	0.085	0.365	0.298	0.029	0.024	0.800
2016	1,921	491	0	0.000	0.085	0.712	0.540	0.091	0.069	1.497
2017	2,016	557	0	0.000	0.085	0.833	0.629	0.115	0.087	1.749
2018	2,116	630	0	0.000	0.085	0.971	0.735	0.145	0.109	2.044
2019	2,221	710	0	0.000	0.085	1.130	0.858	0.181	0.137	2.390
2020	2,331	264	0	0.000	0.104	0.306	0.261	0.017	0.015	0.703
2021	2,446	540	0	0.000	0.085	0.758	0.563	0.084	0.062	1.552
2022	2,567	732	0	0.000	0.085	1.121	0.832	0.160	0.119	2.316
2023	2,694	852	0	0.000	0.085	1.361	1.019	0.215	0.161	2.841
2024	2,828	893	0	0.000	0.085	1.427	1.066	0.225	0.168	2.971
2025	2,968	368	0	0.000	0.085	0.450	0.354	0.028	0.022	0.939
2026	3,114	778	0	0.000	0.104	1.151	0.834	0.144	0.104	2.338
2027	3,269	1,023	0	2.072	0.085	1.643	1.213	0.257	0.190	5.459

Net Present Value discounted at 10% (million $)	-6.339
Economic Rate of Return (ERR)	**4.71%**

Source: Own estimates, based on the GDP growth scenario and Permanent Station traffic samples (MTI, 2012)

6.5 Sensitivity Analysis

Table 30 summarizes the results of the sensitivity analysis were the NPV of the road improvement project was re-estimated for seven scenarios. These scenarios result from the following modified assumptions: delay of one year in the project schedule; increase/decrease in benefits of 10 percent; increase/decrease in costs of 20 percent; and the best and worst case scenarios resulting from the simultaneous changes in costs and benefits.

As shown in Table 30, only in the best case scenario the project could meet SNIP's and OMB's required ERRs to have an economic justification and under none of the scenarios considered in the sensitivity analysis would it meet MCC's required ERR.

Table 30. Sensitivity for VG (method based on GDP elasticity, permanent station)

	NPV (Net User Benefits) discounted at		ERR
	8.0%	10.0%	
Base Case	**($4,574,637)**	**($6,339,440)**	**4.7%**
Sensitivity Scenarios:			
1: Delay 1 year	($5,320,234)	($6,500,803)	3.3%
2: Benefits -10%	($5,793,024)	($7,343,695)	3.7%
3: Costs 20%	($7,926,338)	($9,615,838)	3.1%
4: Benefits 10%	($3,356,251)	($5,335,185)	5.6%
5: Costs -20%	($1,222,937)	($3,063,042)	7.0%
6: Best (Costs -20%, Benefits 10%)	($4,550)	($2,058,787)	8.0%
7: Worst (Costs 20%, Benefits -10%)	($9,144,724)	($10,620,093)	2.2%

Source: Own estimates.

The previous table summarizes results from using the GDP elasticity to forecasts future traffic counts. For completeness, the next table summarizes the results for all three alternative methodologies: time trend, GDP, and population elasticity.

Table 31 Sensitivity for VG (three methods, permanent station)

	ERR (Time Trend)	ERR (GDP)	ERR (Population)
Base Case	**4.6%**	**4.7%**	**4.0%**
Sensitivity Scenarios:			
1: Delay 1 year	3.2%	3.3%	2.6%
2: Benefits -10%	3.6%	3.7%	3.0%
3: Costs 20%	3.0%	3.1%	2.3%
4: Benefits 10%	5.5%	5.6%	4.9%
5: Costs -20%	6.9%	7.0%	6.2%
6: Best (Costs -20%, Benefits 10%)	7.9%	8.0%	7.2%
7: Worst (Costs 20%, Benefits -10%)	2.1%	2.2%	1.5%

Source: Own estimates.

The previous tables use the sample of historic traffic counts from MTI's closest permanent station. Our final sensitivity exercise consists of using a different sample of traffic counts. The next table summarizes the results of the analysis using a smaller sample of more sporadic and variable traffic counts on the individual road (for all three elasticity-based methods of time trend, GDP, and population, respectively. Results for the ERRs are slightly lower however, conclusions about the VG road are not substantially changed.

Table 32. Sensitivity for VG (three methods, road's sample)

	ERR (Time Trend)	ERR (GDP)	ERR (Population)
Base Case	**3.4%**	**3.2%**	**3.1%**
Sensitivity Scenarios:			
1: Delay 1 year	1.9%	1.7%	1.6%
2: Benefits -10%	2.4%	2.2%	2.1%
3: Costs 20%	1.8%	1.6%	1.5%
4: Benefits 10%	4.3%	4.1%	4.0%
5: Costs -20%	5.6%	5.4%	5.2%
6: Best (Costs -20%, Benefits 10%)	6.6%	6.4%	6.3%
7: Worst (Costs 20%, Benefits -10%)	0.9%	0.7%	0.6%

Source: Own estimates.

Table 30 and 31 provide results for all six combinations of methodologies and samples. The average across all of them is presented below in Table 32 and also in the Executive Summary. For example, the ERR values of 4.6, 4.7, 4.0, 3.4, 3.2, and 3.1 result in an average ERR of 3.8% as shown in Table 32.

Table 33. Summary of VG Results (aggregated across methods and samples)

	VG
International Roughness Index	
IRI baseline	12.0
IRI end of compact	1.76
Annual Average Daily Traffic	
AADT baseline (2008)	1,448
AADT end of compact (2010)	1,532
AADT end of study period (2027)	3,482
Net Present Value	
NPV (10%, 2011 US$ mill.)	(7.05)
User benefits	90.33
Incremental costs	-16.38
Economic Rate of Return	
ERR (average across methodologies):	**3.8%**

7 Beneficiary Analysis

Estimates based on Census data and INIDE growth projections suggest that by 2027 the Transportation Project will affect between 205,285 and 252,227 beneficiaries who live within the zones of influence of the three upgraded roads, as detailed in subsections of the report. The range in estimates arises from uncertainty about the growth rate of the population. Estimates are made for a low growth scenario associated with predictions at the departmental level, and a high growth scenario associated with national predictions. Table 34 presents the number of beneficiaries by department, taking into account the overlap in the zone of influence of the S1 and VG projects. Table 36 presents the number of beneficiaries by socioeconomic characteristics.

Table 34 Total Beneficiaries, by Department, High Growth Scenario

	2010	2015	2020	2025	2027
Department of León (S9)	154,259	163,938	172,906	181,114	184,062
Department of Chinandega (S1 & VG)	57,128	60,712	64,033	67,073	68,165
Total Transport Project	211,387	224,650	236,939	248,187	252,227

Source: Own estimates, based on national population growth rates (INIDE, 2007).

Table 35 Total Beneficiaries, by Department, Low Growth Scenario

	2010	2015	2020	2025	2027
Department of León (S9)	146,619	148,180	148,431	148,682	148,783
Department of Chinandega (S1 & VG)	54,513	55,440	56,021	56,377	56,502
Total Transport Project	201,132	203,620	204,452	205,060	205,285

Source: Own estimates, based on departmental level population growth rates (INIDE, 2007).

Table 36 Beneficiaries, by Socioeconomic Characteristic, High Growth Scenario

	2010	2015	2020	2025	2027
Poor	116,908	124,243	131,040	137,261	139,495
Female	110,725	117,672	124,109	130,001	132,117
Adult	141,031	149,879	158,078	165,583	168,278

Source: Own estimates, based on national population growth rates (INIDE, 2007).

Table 37 Beneficiaries, by Socioeconomic Characteristic, Low Growth Scenario

	2010	2015	2020	2025	2027
Poor	111,236	112,612	113,073	113,409	113,533
Female	105,353	106,656	107,092	107,411	107,529
Adult	134,189	135,848	136,404	136,809	136,960

Source: Own estimates, based on departmental level population growth rates (INIDE, 2007).

8 Establishment Survey

In this section we estimate the impact of the road rehabilitation on the availability and prices of goods in affected areas. The analysis uses data from an establishment survey conducted by FIDEG who gathered data on price and availability of goods and services in the Canasta Basica, or basic basket of goods used to calculate Nicaragua's consumer price index.

The establishments in the survey were all located in communities on roads that were originally considered for rehabilitation by MCA-N. Survey teams visited before and after the road rehabilitation in both communities where the rehabilitation took place and in places where it did not. This second group comprises a control or comparison group which is used to identify the impact of the road rehabilitation (treatment) on the availability and prices of goods in the communities.

The ex-ante establishment surveys were conducted in August of 2008 in two rounds of visits to establishments. The first round took place between August 11th and 16th and resulted in 210 visits and 209 completed surveys. In the second round, which took place between August 25th and August 30th 226 establishments were visited and 200 surveys completed.

For the ex-post establishment survey FIDEG conducted two rounds of data collection between August 30th and October 1st, 2010. The first round of 272 visits to establishments occurred between August 30th and September 3rd and yielded 224 completed surveys. The second round of 221 visits occurred between September 27th and October 1st and yielded 209 completed surveys, for a total of 433 completed surveys. The final dataset of completed surveys contains 842 observations from the two years of data collection. The conduct of two rounds of surveys for both pre- and post-rehabilitation measures is a useful practice as it insures that random shocks reflecting rare events that might influence findings on a single visit have a smaller impact on the data.

We examine alternative definitions of treatment and control groups in our attempt to understand the impacts of the rural road rehabilitation. The first specification is consistent with the definitions of zone of influence in the feasibility studies developed by MCA-N and all communities not on the S1, S9, or VG roads are considered control communities. This definition yields observations in 12 (17) treatment (control) communities. A thirtieth community has observations in only the base year. Other researchers have proposed that roads have a broader zone of influence and we examine this possibility in two ways. In some models we introduce an indicator variable that distinguishes between establishments that are directly on the road from those elsewhere in the surveyed community. We also consider whether establishments are affected in a broader zone of influence as discussed by Torero (2009). This alternative specification may be particularly important in Chinandega, since many communities on the S2 and S3 control roads are close to the S1 rehabilitation and communities on the S4 control road are close to the VG construction. Thus, as a robustness check we measure treatment effects with these nearby communities considered to be in a broader treatment area.

At the time communities were selected for the establishment survey it was not known which roads would be included in the transportation project and so matching of treatment and controls based on specific characteristics was not possible. Ex-post measures indicate that, with one exception, treatment and control values of community characteristics are not significantly different. The exception is the level of *extreme poverty* which is greater in treatment than control communities. Because of this difference across groups, in addition to the differences-in-differences methodology prescribed in the scope of work, we also make use of propensity score matching methods in which control communities with similar characteristics receive heavier weights when matches with treatment communities are created.

Table 38, Community Characteristics

Treatment	Extreme Poverty	Population	Electric Light	Unemployment	Ag. Sector
0	35.49	637.88	72.85	3.55	60.89
1	49.16	1017.20	83.62	5.49	55.90
Total	41.14	778.37	77.30	4.38	58.75

Note: With the exception of the measure of extreme poverty, both rank-sum and t-tests find no statistically significant differences in characteristics of treatment and control communities.

8.1 Identifying causal effects

For any definition of treatment and control, the identification of impacts makes use of a difference in difference methodology in which outcomes of interest are compared before and after rehabilitation in both treatment and control units. The units for which treatment effects are measured may be either establishments or communities. Elsewhere in the evaluation we also consider households as units of observation. In general, the difference in difference measure for a unit, DD_i is given by

$$DD_i = y_{i1t} - y_{i0t} - (y_{j1c} - y_{j0c}),$$

where y_{ikj} is the outcome for the i^{th} unit in year *k* in either the treatment or control condition. The empirical approaches developed for impact evaluation are designed to address the fact that observations in both treatment and control conditions are not obtainable for a given unit *i*. As noted previously, the development of an appropriate counterfactual for the treated roads requires a comparison to relevant control units. We examine several approaches for the identification of treatment effects that include the use of regression models and weighted matching methods that make use of propensity scores. The matching methods identify specific units in the control group that are similar to treated units with respect to the probability of being included in the treatment. These methods have slightly different statistical properties and we examine several models in order to assess the robustness of specific results.[8]

The propensity score methods use more than one control unit to match with a single treated unit. In this case the control units are weighted by their contribution to the difference so that the weighted double difference measure is given by

$$DD_i^W = y_{i1t} - y_{i0t} - \sum_{j \in C} W_{jc} \left(y_{j1c} - y_{j0c}\right).$$

where the weight W_{jc}, depends on the distance of unit *j*'s propensity score from unit *i*'s propensity score and the sum of the weights is equal to one.

[8] Angrist and Pischke (2009) call the matching and regression approaches "parallel universes." Khandker et al. (2010) provides an overview of the evaluation methods used in this report.

Averaging across the double difference measure for different units yields the average treatment effect (ATE) for the sample,

$$ATE = \sum_{i \in T}\left[(y_{i1t} - y_{i0t}) - \sum_{j \in C} W_{jc}\left(y_{j1c} - y_{j0c}\right)\right]/N_T.$$

For the establishment survey a set of propensity scores were estimated prior to selection of communities for inclusion in the sample (FIDEG 2010). The results from this model are used as a baseline for the ex-post matching and augmented with additional census data on community characteristics to identify appropriate controls.

Estimation of treatment effects

Difference and difference models are estimated for both number of goods available (*count*) and the prices of goods (*price*). For the models with *count* as the dependent variable estimates are reported at the establishment and community level. The exact econometric specification used will depend on whether there exists a balanced panel or unbalanced panel for the model. Community level models will have observations in both time periods and so a differencing model as in equation 1 is appropriate.

$$\Delta y_i = \beta_o + \beta_1 D_i + u_i \qquad \text{Equation 1}$$

Here Δy_i is the change in the outcome variable for community i across years, D_i is a dummy variable taking the value of 1 when the community is within the zone of influence of a rehabilitated road and 0 otherwise. The betas are parameters to be estimated and u_i a mean zero error term. β_1 is the parameter of interest that identifies a treatment effect.

Establishment level models are also estimated and due to entry and exit not all establishments appear in both years of the study. Since the panel is not balanced we estimate an equation without differencing the outcome variables.

$$y_{it} = \beta_o + \beta_1 D_i + \beta_2 year + \beta_3 year * D_i + u_{it}, \qquad \text{Equation 2}$$

The outcome variable is measured for establishment i in year t, and the impact of the treatment is captured by the coefficient β_3 for the interaction term $year * D_i$ with year equal to 1 in 2010 and 0 in 2008.

Additional control variables are possible in either model. We are particularly interested in differential impacts in urban and rural areas and investigate this effect by, by either inserting an indicator variable *urban* on the right side of the equation which equals 1 (0) in urban (rural) areas. The *urban* variable is interacted jointly with year and treatment to generate estimates of the treatment effect in urban areas. For ease of interpretation separate regressions for urban and rural areas are also reported in several instances. Estimates at the establishment level will also control for the type of establishment. The bulk of the establishments are small grocery stores (pulperias), however, a number of supermarkets and distributors were also included in the survey. In addition, because of the possibility of dependence in outcomes across communities along the same roads, we estimate models with error component specifications to control for community- and road-specific factors that are common across time.

8.1.1 Availability of goods

In this section we examine the evidence on whether the rehabilitation of the roads affected the number of goods available both in specific establishments and in communities, first presenting simple descriptive statistics, then drawing conclusions from difference-in-differences estimation and propensity score matching methods.

Availability at the individual establishment level

Exploratory analysis of descriptive statistics reveals a general trend; more components of the Canasta Basica are available in 2010 than 2008 in the surveyed establishments. The average increase is 2.73 items and unconditional statistical tests (t-tests) indicate that the difference across years is significant in aggregate and also when examining establishments in the treatment and control zones independently. The increase is slightly larger in the control communities than in the treated, implying that difference in difference measures will yield a negative treatment effect in aggregate. Table 39 summarizes the initial results, displaying the mean and standard deviation of item counts by establishment, and the number of observations.

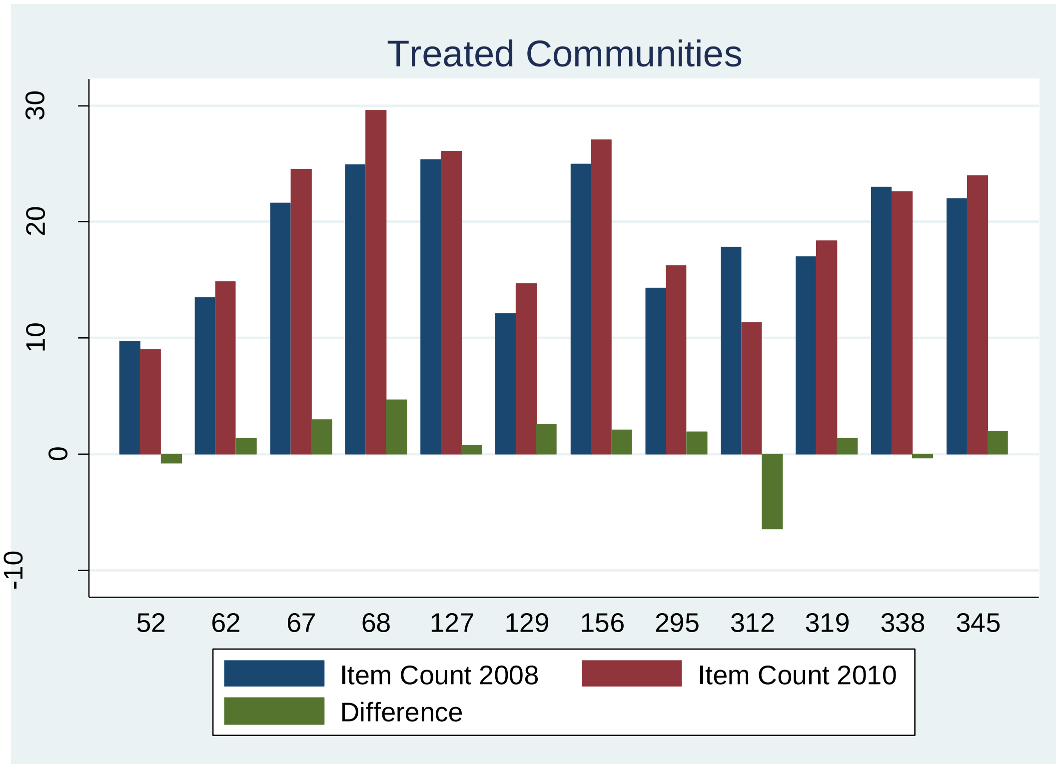
Table 39. Availability of Canasta Basica items, observations at establishment level

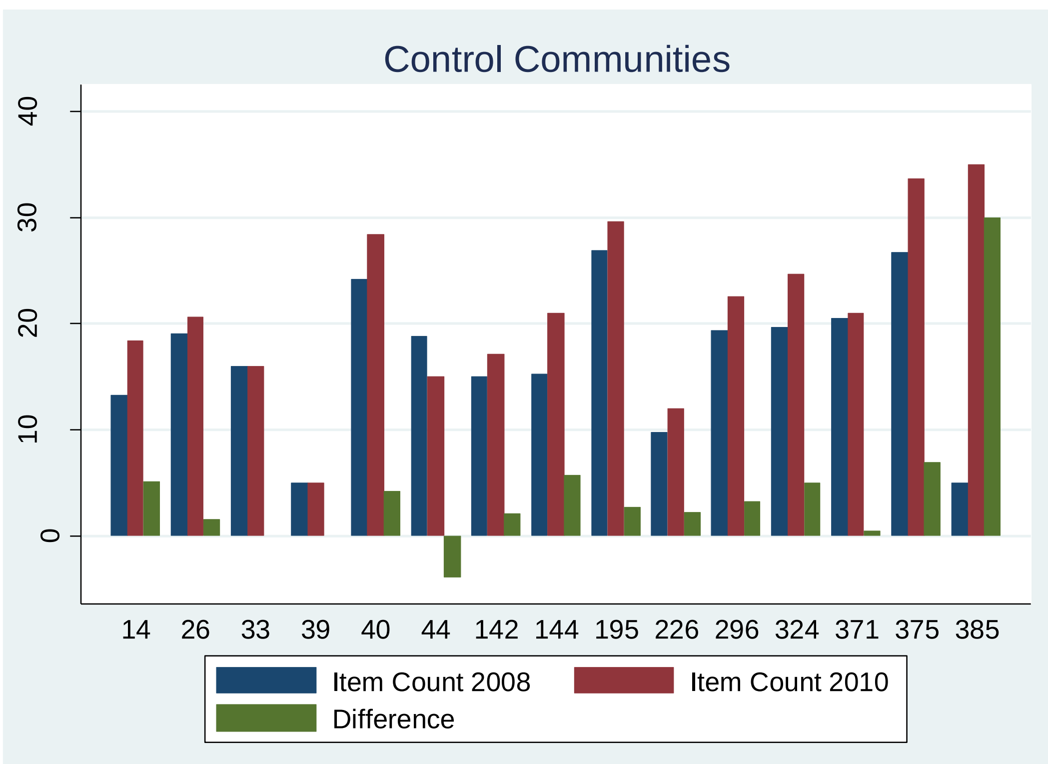
	Control Establishments		**Treatment Establishments**		**All Establishments**	
Statistic	2008	2010	2008	2010	2008	2010
Number of Items	17.99	21.06	18.72	20.96	18.29	21.02
Std. deviation	10.72	11.64	9.97	11.72	10.41	11.67
Observations	243	235	166	198	409	433

T-tests reveal that the increase in item availability from 2008 to 2010 is statistically significant for establishments in both treatment and control communities and in aggregate.

Figure 14 presents related results on availability of goods at the community level for both treatment and comparison groups. The graphical presentation demonstrates that there is significant heterogeneity in responses across communities even with treatment and comparison groups. In the treatment group, a small community on the S9 road, La Ceiba (312) shows a significant decline on average of more than six items in the Canasta Basica for establishments in these communities. In the second panel a notable increase occurs in one of the control communities on the S13 road, Villa Operadoras in Nagarote (385). Because of the small number of observations associated with these communities (28 of 842) the substantive conclusions on changes in item availability are robust to inclusion or exclusion of these communities.

Figure 14: Mean Item Counts by Establishment in Treatment and Control Communities





Note: community codes are identified in Appendix B.

Further examination of the data makes use of the establishment level regression model (Equation 2) where *Trt* is the indicator variable for treatment (1) and control (0), and is augmented by an urban indicator variable, by a term interacting treatment and urban status, as well as categorical variables for the establishment type. Parameter estimates are reported in Table 40. The first column (Model 1) reports estimates with treated establishments in the default zone of influence identified in the previous sections of the report. Model 2 adds an identifier for establishments located directly on the road. Model 3 expands the zone of influence to incorporate communities within 30 minutes of a rehabilitated road in the treatment category. Model 4 adds the indicator variable for *Road* to the Model 3 specification. All regressions control for establishment type and implement an error components specification to control for time-persistent unobserved factors at the road, community, and establishment levels.

Consistent with the summary statistics in Table 39, the sign of the coefficient measuring the main treatment effect (Trt x Yr) is negative. This result is partially offset for establishments directly on the road. Examining item availability by type of establishment, we observe that distributors have fewer items from the Canasta Basica in stock than establishments identified as pulperias which is the omitted category in the regression model. Pulperias predominate in the establishment survey (n = 613). The number of distributors is small (n = 23) and the bulk of those in León (n = 17) are small operations that on average sell 18 of the items in the Canasta Basica. The small number of distributors located outside of León are somewhat larger and sell on average 35 items. Establishments in urban areas have 5.7 more items in stock than those in rural areas, however, the results do not indicate strong effects of road rehabilitation on the availability of goods in establishments. To the extent that there is an effect, it is narrowly focused, spatially, on those establishments directly on the rehabilitated road and not on those in broader zones near the road.

Table 40. Availability of items in basket, observations at establishment level

Variable	Model 1	Model 2	Model 3	Model 4
Trt	0.64	0.657	0.656	0.786
	0.75	0.736	0.763	0.715
Yr	3.659	3.664	3.617	3.62
	0.000	0.000	0.000	0.000
Trt x Yr	-2.412	-4.026	-1.96	-3.374
	0.004	0.000	0.037	0.006
Urb	7.623	7.623	9.316	9.164
	0.000	0.000	0.017	0.014
Trt x Urb	-2.049	-1.866	-3.519	-3.434
	0.51	0.536	0.412	0.401
Trt x Yr x Urb	0.077	0.102	0.694	0.625
	0.930	0.908	0.346	0.396
Distributor	-5.063	-4.949	-5.367	-5.227
	0.001	0.002	0.001	0.001
Supermarket	-7.931	-9.037	-7.337	-8.362
	0.000	0.000	0.000	0.000
Other	-13.696	-13.717	-13.796	-13.868
	0.000	0.000	0.000	0.000
Road	n/a	0.545	n/a	0.777
		0.774		0.685
Trt x Yr x Road	n/a	2.085	n/a	1.753
		0.038		0.064
Constant	17.097	16.727	17.096	16.534
	0.000	0.000	0.000	0.000
N	842	842	842	842
ll	-2.674.67	-2.672.27	-2.679.51	-2.677.46
aic	5377.337	5376.547	5387.025	5386.872

For each variable, p-values are displayed below parameter estimates. Models 1 through 4 use different treatment and comparison group definitions. Model 1 is consistent with the default zone of influence, while Model 2 adds an indicator (*Road*) if the establishment is directly on the road. Model 3 expands treatment to include communities within 30 minutes of the road, and Model 4 incorporates the *Road* variable into the specification with the broader treatment area.

Implementing a matching model in which establishments are matched on (i) urban/rural location, (ii) establishment type, and (iii) whether the community is located directly on the road yields average treatment effects that have a negative sign, as would be expected from the previous results, however the t-statistic is low indicating that the differences cannot be distinguished from statistical noise. The Average Treatment Effect (ATE) is negative in aggregate and in rural areas, but becomes slightly positive, in urban areas, although the difference is not statistically significant.

Both matched (with propensity scores) and unmatched (difference in differences) treatment effects are summarized in Table 41. None of the treatment effects estimated at the establishment level are significant, neither in the matching model nor in the unmatched model, as evidenced by the small t-statistics.

Table 41. Canasta Basica, establishment level ATE for item count

Sample	Matching	Treated	Controls	Difference	T-stat
All	Unmatched	1.434783	2.788043	-1.35326	1.36
	Matched	1.434783	2.521739	-1.08696	0.20
Urban	Unmatched	1.631579	2.540323	-0.90874	0.74
	Matched	1.631579	1.421053	0.210526	0.19
Rural	Unmatched	1.193548	3.300000	-2.10645	1.21
	Matched	1.193548	3.870968	-2.67742	0.31

Matched estimates make use of weighted propensity scores to create the comparison group.

Aggregated availability at the community level

The average count, by establishment, is one way to examine the availability of goods in communities, but it is not necessarily the most informative for gauging project impacts. Heterogeneity across establishments within a community may mean that a much larger proportion of the goods in the Canasta Basica are accessible in the community than is indicated by the previous discussion of establishment level item counts. The next set of results identifies changes in availability of goods within the community after accounting for the inventory of all establishments.

Table 42**Error! Reference source not found.** is the analog of Table 39 and presents the cross-tabulations of aggregate item availability at the community level by treatment/control and by year. The table documents that the community level item count increases in both treated and control regions, however, in this case the increase is larger for the treated group.

Table 42: Community Level Item count by treatment and year

	Control Communities		Treatment Communities		All Communities	
Statistic	2008	2010	2008	2010	2008	2010
Number of Items	36.00	37.94	35.83	39.75	35.93	38.69
Std. deviation	12.81	11.59	10.82	9.91	11.82	10.78
Observations	17	17	12	12	29	29

Table 43**Error! Reference source not found.** presents differences in item availability by treatment and location (urban/rural) and we observe that there is an increase in the number of items available in treated communities in both rural and urban areas. Using an unconditional Wilcoxon matched-pairs test, which is suitable for small samples, we find that the increase in the treated urban areas (3.5 units) is statistically significant and represents a 10% increase in the

availability of Canasta Basica goods. The change in rural areas is 1.3 units and is not statistically significant.

Table 43: Difference in Community Level Item count by treatment and urban/rural

	Control Communities		Treatment Communities		All Communities	
Statistic	Rural	Urban	Rural	Urban	Rural	Urban
Number of Items	2.83	-0.20	4.13	3.50	3.35	1.44
Std. deviation	3.64	0.84	3.91	2.65	3.70	2.60
Observations	12	5	8	4	20	9

Supporting evidence of a treatment effect from regression analysis and matching models, however, is modest. Using five nearest neighbor's propensity scores to define a comparison group yields an average effect of 2.55 additional items available in treated communities. The difference, however, is not significant at conventional levels.

The regression model used to estimate community level effects follows equation 1. The results for this specification are presented in Table 44, with the negative coefficient on the *Treat* variable indicating a decline in rural treated communities relative to control group. An F-test on the joint impact of the coefficients associated with the urban treated areas is also marginally significant (p=0.09) indicating in this specification a slight increase in item availability in the treated urban areas. The results on the number of goods available are consistent with t-test results indicating a negative treatment effect for the rural areas.

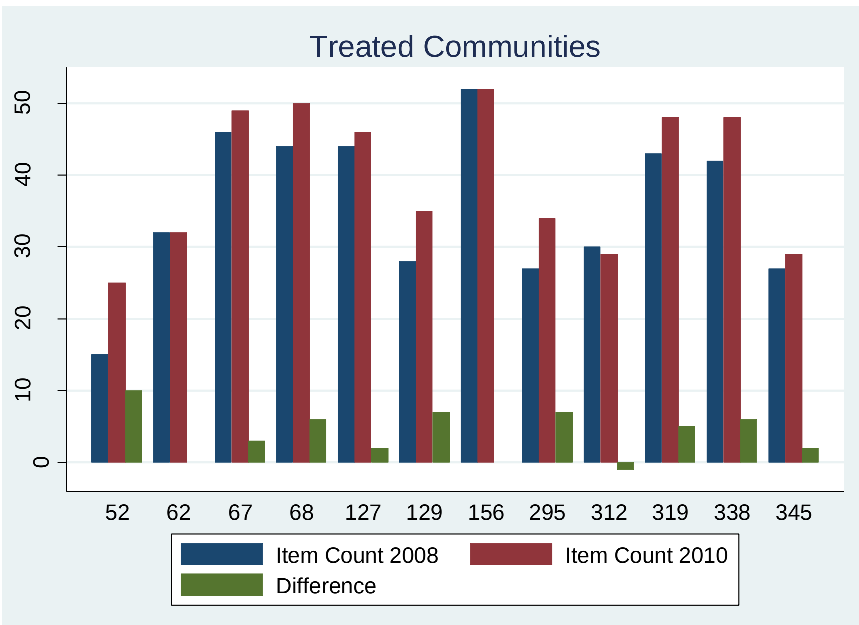
Table 44. Canasta Basica establishment count treatment estimates, community level

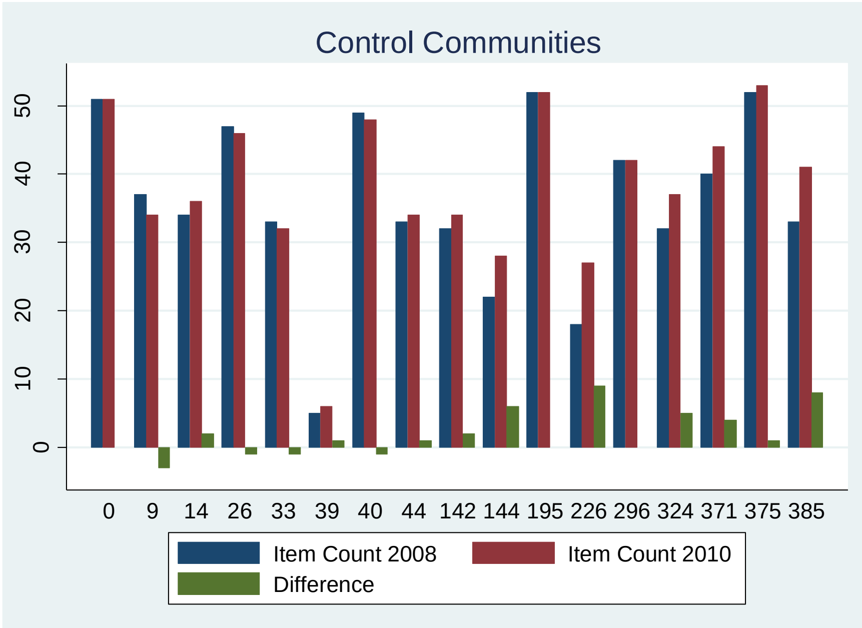
Variable	All
Treat	-3.45818
	0.0221
Urban	-0.62253
	0.7095
TrtXUrban	4.479232
	0.0875
_cons	3.02871
	0.0024
r2	0.222364
N	29

Overall the results on item availability are quite mixed, with some evidence of an increase in availability of goods in urban areas and some suggestion that adjustment dynamics to the road rehabilitation are incomplete.

Further insight on the availability of items can be gained by looking at changes in the types of items available. For this purpose we make use of the division of the Canasta Basica into eight categories that include (i) staple foods such as rice, beans, sugar, and cooking oil, (ii) meat, fish, and poultry, (iii) dairy and eggs, (iv) cereals, and (v) produce, (vi) household goods that include paper products, soaps etc, (vii) rent, and utilities, and (viii) clothing. Examination of the share of goods available in each category reveals negative treatment effects within categories (iii) meat, fish, and poultry, and (vi) cereals, implying that fewer items are available as a result of the rehabilitation. Results support the more general models as the reductions observed are focused in rural areas. This result suggests that short-term adaptations may be associated with increased consumer travel to urban areas or possibly with reduced consumption which, very speculatively, could be due to credit constraints. Full results for the regressions on item counts by categories of the Canasta Basica are found in Appendix C : Establishment Survey Detailed Results

Figure 15: Item Availability by Community, Treatment and Controls





8.1.2 Prices of Goods in Canasta Basica

Estimates of treatment effects for the price of goods are conducted first for each good individually, distinguishing rural and urban communities. The difference in difference estimator for good i is measured as

$$DD_i = p_{i1t} - p_{i0t} - (p_{i1c} - p_{i0c}),$$

and is estimated using the establishment level empirical equation augmented by an additional interaction with the urban/rural area indicator variable.

$$y_{ij} = \beta_o + \beta_1 D_i + \beta_2 year + \beta_3 year * D_i + \beta_4 urban + \beta_5 urban * year * D_i + u_{ij}$$

The magnitude of a treatment effect in rural areas is identified by the coefficient β_3 and in urban areas by $\beta_3 + \beta_5$. Additional controls for establishment type and community level fixed effects are also included.

Details on the magnitude of the price changes are in Table 45, and the individual regression results for each good are in Appendix C. This specification reveals that thirteen of the forty-eight goods exhibit a significant treatment effect in the rural areas. Changes are observed in several food categories as well as in household costs, and clothing. Eight of the thirteen price changes in the rural areas reflect price declines. In urban areas, only a single good – Detergente (good 25) - exhibits a significant treatment effect.

The net effect on the value of the basket is just under 1% in both urban and rural areas. In rural areas there is a 0.97% decline in the cost of the basket relative to the control group from 5,663 to 5,608 cordobas. In urban areas, the relatively large price increase - greater than 100% - for the one good that has a significant change yields a 0.91% increase in the overall value of the basket. These figures omit the values for rent and utilities - category 7 of the costs – which are not sold at specific establishments.

The impact on cost-of-living for subcategories of the Canasta Basica is also reported in Table 46. There is an overall decline in the cost of food in the Canasta Basica in rural areas where road rehabilitation took place. Changes include a 4.3% decline in food staples, and a nearly 20% decline dairy and egg products. Modest increases in produce (2.6%) and meats (2.8%) relative to the unimproved roads partially offset the declines. In the urban areas, a large (110%) increase in the cost of detergent lead to an 11% increase in the category of household costs, and a 0.91% increase in the overall Canasta Basica in the treated areas.

A limitation of the analysis is that, while the price changes associated with the Canasta Basica are revealing, they do not translate directly into welfare measures since we cannot draw conclusions about the actual patterns of consumption from these data. Furthermore, only a subset of the goods consumed by households is included in the Canasta Basica, and durable goods are absent. Further, price changes have diverse impacts since the affected population contains both consumers and producers. The household surveys containing explicit consumption measures, particularly for food, provide more detailed information on these questions.[9] However, despites its limitations, the establishment survey has several strengths. First, it clearly identifies the price of the good, which is often confounded and likely to be subject to more significant measurement error in household surveys. Confounds in the household surveys arise when questions yield data only on values and not separately on price and quantity, and when there is significant variation in quality. In the establishment survey the quality of the goods is largely held constant across establishments, and concerns about respondent recollection are not significant factors. The inclusion of two rounds of data collection for both ex-ante and ex-post measurement is another strength of the establishment survey. The repeated visits to establishments add robustness to the results since the importance of random shocks in the availability of goods is mitigated (McKenzie, forthcoming).

[9] It should be noted that although the household surveys provide additional information, the respondents are not a random sample of the study area. Thus the results presented in Section 9 only provide indications of the nature of the effects and not robust estimates.

Table 45: Canasta Basica with Price Changes (establishment level estimates)

Category/item code	Category/item description	Unit	Monthly consumption	Treatment Effect Rural	Treatment Effect Urban
One	**BASIC FOODS**				
1	Rice	Lbs.	38		
2	Beans	Lbs.	34	-8.37%	
3	Sugar	Lbs.	30	-8.12%	
4	Oil	Liter	7		
Two	**MEAT, POULTRY, FISH**				
5	Beef	Lbs.	8		
6	Pork	Lbs.	5	11.58%	
7	Poultry	Lbs.	8		
8	Fish	Lbs.	9		
Three	**DAIRY AND EGGS**				
9	Milk	Liter	30		
10	Eggs	Dozen	7	-16.40%	
11	Cheese	Lbs.	9	-21.58%	
Four	**CEREALS**				
12	Tortilla	Lbs.	57		
13	Pinolillo (a)	Lbs.	10		
14	Pasta	Lbs.	5		
15	Bread	Lbs.	27		
Five	**PRODUCE**				
16	Tomato	Lbs.	14	30.93%	
17	Onion	Lbs.	8		
18	Potato	Lbs.	15		
19	Squash	Lbs.	32		
20	Pepper	Lbs.	3		
21	Banana	Lbs.	16		
22	Orange	Lbs.	46		
23	Cabbage	Lbs.	2		
Six	**HOUSEHOLD COSTS**				
24	Soap	Unit	12.55		
25	Detergent	Bag of 40 grs	27.97	28.54%	112%
26	Toothpaste	Unit of 115 grs	2.13	-6.19%	
27	Matches	Box of 40	10.87		
28	Broom	Unit	1.22	--5.78%	
29	Toilet paper	Rol	10.71	-7.07%	
30	Hand Soap	Unit	4.67		
31	Sanitary napkins	Bag of 10 units	2.21	8.25%	
32	Deodorant	Unit	1.9		
33	Toothbrush	Unit	2.49		
Seven	**UTILITIES**				
34	Rent	Monthly C$	1		
35	Butane gas	25 lbs	1		
36	Electricity	KWH	100		
37	Water	Galon	5,292		
38	Transport	ticket	240		
Eight	**CLOTHING**				
	CLOTHING – MEN				
39	Jeans	Unit	0.62		
40	Shirt	Unit	0.66		
41	Underwear	Unit	1.57	18.72%	
42	Socks	Pair	1.32	12.44%	
43	Shoes (natural leather)	Pair	0.43		
	CLOTHING - WOMEN				
44	Shirt	Unit	0.66		
45	Jeans	Unit	0.51		
46	Dress	Unit	0.5		
47	Underwear (panties)	Unit	1.23		
48	Underwear (bras)	Unit	0.97	-22.03%	
49	Sandals (synthetic leather)	Pair	0.44		
	CLOTHING - CHILDREN UNDER 10 YEARS OF AGE				
50	Complete suit	Unit	0.5		
51	Underwear	Unit	1.43		
52	Socks	Pair	1.39		
53	Shoes (synthetic leather)	Pair	0.45	68.3 %%	

Note: (a) Pinolillo is a traditional mixture of ground toasted corn and cacao.
Source: Own estimates based on Establishment Survey.

Table 46: Mean Basket Value change due to treatment (establishment level estimates)

Goods	Location	Ex-Ante	Ex-Post	Difference	% Change
All	Rural	5663.41	5608.47	-54.94	-0.97%
	Urban	7133.17	7197.85	64.68	0.91%
Staple Foods	Rural	1368.90	1310.06	-58.84	-4.30%
	Urban	1353.12	1353.12	0.00	0.00%
Meat	Rural	586.39	602.90	16.51	2.82%
	Urban	790.57	790.57	0.00	0.00%
Dairy and Eggs	Rural	532.39	429.08	-103.31	-19.41%
	Urban	1020.20	1020.20	0.00	0.00%
Cereals	Rural	454.92	454.92	0.00	0.00%
	Urban	647.13	647.13	0.00	0.00%
Produce	Rural	1230.00	1261.43	31.43	2.56%
	Urban	1764.20	1764.20	0.00	0.00%
Household Goods	Rural	608.46	624.85	16.39	2.69%
	Urban	577.59	642.26	64.68	11.20%
Clothes	Rural	882.35	925.23	42.88	4.86%
	Urban	980.38	980.38	0.00	0.00%

9 RBD Household Survey Results

9.1 RBD Treatment Effects

Surveys conducted for the Rural Business Development component of the Nicaragua compact comprise a repeated cross-section of communities, and were not designed specifically to evaluate the Transportation Project. However, the timing of the surveys, in 2007, 2009, and 2011, and the fact that some of the respondents were in the zone of influence of treated and control roads allows for further exploration of the impacts of the road project. The contribution of these studies is that actual consumption is reported, data which is absent in the establishment surveys for goods in the Canasta Basica. However, the subjects comprise a biased sample of the regions population.

The main goal in this section is to examine whether the effects observed in the establishment survey are consistent with the more detailed results available from the RBD surveys, which were conducted as repeated cross-sections of communities. Recall that the establishment survey saw relatively small aggregate changes in the average basket value; aggregate differences were less than one percent. Certain components of the basket, however, saw significant changes. In particular milk and eggs – perishable and fragile goods – declined significantly in price. In this section in addition to estimating aggregate consumption expenditure we report on differences in consumption across categories of goods that appear in the basic basket. This is data that is absent from the establishment surveys.

Estimates reported in this section make use of the pre- and post-rehabilitation surveys conducted in 2007 and 2011. A double difference model is estimated in which the explanatory variables include the treatment indicator variable and the urban/rural indicator which proved important in the analysis of the Canasta Basica results. In addition, the models make use of household characteristics, and community level fixed-effects to better understand potential treatment effects. Control variables include detailed information on the construction materials of the dwelling, the number of rooms, sources of light, water, cooking fuel, and method of waste disposal, as well as the number of persons in the household.

Outcome variables that are examined include aggregate consumption expenditure as well as aggregated food, and transportation expenditures. Because these variables confound price and quantity changes, we also construct quantity indices for food consumption since both quantity and expenditure data is available for this category of goods. We are particularly interested in changes in quantity of consumption in order to get a different perspective on impacts than those obtainable from the user cost measures consumer price indices developed in previous sections.

The estimation equation for household i in year j and treatment t is as follows:

$$y_{itj} = \beta_o + \beta_1 D_t + \beta_2 year + \beta_3 year * D_t + \beta_4 urb + \beta_5 urb * year * D_t + \beta X + u_{itj}$$
(Equation 3)

The matrix X contains household-level controls and community fixed effects. For each outcome variable we examine models which vary with respect to their definition of treatment and control groups. The first set of reported results is in Table 47 present treatment effects for per capita consumption. Model 1 uses the narrowest definition of the zone of influence of the roads, and control communities are restricted to those in the zone of influence of control roads considered for rehabilitation by MCA-N. Model 2 expands both treatment and controls to more distant communities, defined as within 30 minutes of treatment or control roads. Model 3 retains Model 2's definition of the treated households but expands the control households to all others in the RBD sample. All models reveal a decline in per capita expenditure in rural areas.

Table 47: Per Capita Consumption Expenditure: RBD Panel Data Estimates

Variable	Model 1	Model 2	Model 3
Year	4130.827	2564.338	2264.449
	0.0035	0.0003	0.000
trt	8839.879	1766.691	4659.441
	0.593	0.8185	0.4602
Year X trt	-9738.12	-2823.66	-2139.33
	0.0487	0.0728	0.1144
urban	2899.218	3688.251	5784.437
	0.2884	0.0215	0.000
trtXyrXurb	1864.613	10024.95	7203.754
	0.8439	0.0024	0.0224
hhsize	-1513.86	-1574.49	-1470.04
	0.000	0.000	0.000
_cons	97193.01	104277.6	39387.94
	0.000	0.000	0.000
chi2	482.5121	976.8527	1524.682
r2	0.662325	0.512372	0.392879
N	297	1082	3103

Note: Household Characteristics and Community fixed effects are included in the models but omitted from presentation of results.

Models 1 and 2 reveal a significant decline in per capita expenditure in rural areas as evidenced by the interaction of the *Year* and *Trt* indicator variables. The decline is puzzling, however, one possibility is that opportunities created by the road rehabilitation spur investment, causing a decline in consumption due to credit market imperfections. Models 2 and 3 identify a treatment effect associated with increased per capita consumption expenditure in urban areas as evidenced by the magnitude and sign of the interaction between *YearXTrtXUrban* which more than offsets the negative value of the *YearXTrt* coefficient yielding estimates of increases in consumption expenditure between 8% and 12% in urban treated areas. Models with the same specifications as those in Table 47 are estimated also for transportation expenditure, however, no significant treatment effects are observed. Detailed results for these models are presented in Appendix B.

Table 48 presents treatment effects for food consumption estimated from the RBD survey responses in 2007 and 2011. The dependent variable in these models is the quantity consumed by a household in a specific year. The model thus follows Equation 3 as in the previous examination of outcomes from the household surveys. Household characteristics and community fixed-effects are used as regression controls along with the treatment indicator variables reported in the table of results. Quantity variables are created for aggregate food consumption and for subcategories that correspond to the food components of the Canasta

Basica. The quantity variables are created from the value of consumption for up to 83 items with the value deflated by Fischer price indices for the 2011 data. The Fischer index is defined as the geometric mean of the Paasche and Laspeyres price indices. Note that the categories of food consumption are consistent with those in the Canasta Basica, however, the actual items consumed often differ since the household survey contains responses on a much larger variety of food items than those contained in the Canasta Basica.

Significant treatment effects are observed for dairy and eggs (Q3), and produce (Q5) both of which indicate increases in consumption in the treated areas, for produce this is in the urban areas only. The increase in consumption for Q3 is identified by the significant coefficient on the *TreatXYear* interaction term, but there is no independent effect distinguishing rural and urban areas. The increase in consumption of dairy and eggs in rural areas is notable because of the complementary decline in prices observed in the establishment survey. Further the magnitude of the increase relative to control areas is quite large – nearly 68%. For produce, the treatment effect is isolated to urban areas and the quantity change reflects a roughly 20% increase in consumption. Both of these results suggest that the improved roads have improved access to perishable and fragile items.

Table 48: Food Quantity Treatment Effects, RBD Panel Data Estimates

Variable	Q1	Q2	Q3	Q4	Q5	Q Aggregate
				-		
Treat	17.800	-63.738	-13.866	207.963	-663.213	-872.941
	0.927	0.392	0.766	0.340	0.069	0.169
Year	3.929	-4.832	25.732	16.264	-39.418	-1057.510
	0.749	0.250	0.000	0.158	0.058	0.000
Treat X Year	12.816	-4.133	17.942	-26.597	-44.200	-77.236
	0.639	0.646	0.023	0.320	0.341	0.363
Urban	-12.763	15.444	9.926	6.627	-14.686	66.713
	0.644	0.070	0.125	0.790	0.749	0.434
TrtXYearXUrb	-41.843	7.060	-3.308	38.888	202.802	-159.571
	0.497	0.705	0.836	0.478	0.058	0.379
Household Characteristics and Community Fixed-Effects Omitted						
	-					
Constant	235.260	32.077	-23.234	575.118	1001.917	1624.918
	0.362	0.655	0.610	0.006	0.004	0.052
r2	0.256	0.281	0.368	0.237	0.246	0.601
N	930	874	640	887	1001	1006

Index categories: (Q1) Staple foods, (Q2) Meats, (Q3) Dairy and eggs, (Q4) Cereals, (Q5) Produce

10 Recommendations and Conclusions

In this study we report the results from three empirical approaches that individually and collectively shed light on economic impacts and economic returns of the MCA-N Transportation Project. Two of the methodologies – the ERR analysis and study of the establishment survey - rely on data collected specifically for the evaluation. The other relies on household survey data collected to evaluate the Rural Business Development portion of the compact. In all cases measurement of effects of the road rehabilitation are made from measurements of outcomes before and after the construction took place and include comparisons to control groups.

Aggregate estimates of the impacts of the Transportation Project are, in general, modest. Measures of economic rate of return that incorporates direct user benefits and estimates of non-user benefits reveal that only the S9 road had, at the time of the data collection, achieved the benchmark 8% rate of return. The S1 and VG roads require increases in benefits of 35% and 26%, respectively to achieve the 8% level. Similarly, the establishment survey identifies modest changes in aggregate cost of living in treated areas. Percentage changes of less than 1% in the cost of the market basket are observed in treated areas. In rural areas there is a small decline (-0.97%) and in urban areas a small increase (0.91%) in the value of the basket.

At a more disaggregated level, both the establishment survey, and the household survey yield results that suggest some important changes in the economy are underway due to the Transportation Project. Treatment effects for perishable items – dairy, eggs, and produce – are observed that are both economically and statistically significant. Household surveys reveal treatment effects for quantities consumed that include increases of 68% for the dairy and egg category and 20% for produce, although the latter effect is observed only in urban areas. The result for dairy and eggs seems particularly robust, as the increase in consumption identified in the household survey is supported by a significant price reduction in the establishment surveys.

The evaluation of the Transportation Project contains both strengths and weaknesses. An important strength is the use of the establishment survey which provides detailed, community-level data on the availability and prices of the basket of goods used to calculate the consumer price index in Nicaragua. Ordinarily these data, if available at all, are not available with the same consistency of coverage as provided by this survey. The establishment survey was conducted with care and has yielded high quality data that facilitates comparisons across diverse communities. Adding to confidence in the results are the two distinct rounds of data collection conducted both before and after construction, making the results more robust to timing issues for the availability of goods. This approach reduces concerns that random shocks drive the results. Although a formal cost-benefit analysis of the data collection was not possible, this method of allocating resources for data collection appears to be highly worthwhile.

The establishment survey does have limitations with respect to the type of questions it can address. The data on price and availability of a subset of goods does not provide sufficient information to address the welfare impacts of the project on individuals or households or even aggregate impacts.

An expansion of the scope of the establishment survey could be beneficial if this approach is to be used in future studies. Expanding data collection to include quantities as well as prices would be informative for measures of aggregate consumption. Additional information could be elicited from shoppers regarding their travel routes to the establishments. In addition information from the establishments on the origin of the goods for sale would be useful for identifying impacts. The establishment survey methodology could also be broadened by surveying additional types of establishments that include schools, hospitals, and sellers of durable goods and equipment. This latter possibility would support the generation of more robust measures of the road rehabilitation on determinants of well-being.

Potential expansion of the establishment survey methodology should be weighed against alternatives. One possibility would be to make use of more detailed traffic count and origin and destination data. The more standard alternative is collect more detailed data using household surveys. The opportunity to examine broader measures of well-being that include accessibility to health care, education and other services – as well as nonmarket consumption and consumption of goods purchased outside of community establishments - is a clear benefit of the household survey methodology. In the current evaluation the availability of household surveys associated with the RBD Project serve as a reasonable substitute for project specific household surveys. However the selection into the sample for the RBD was not intended to be representative of the population as a whole. Evaluators have also devised mobility surveys that have a more restricted focus on activity related to travel.

One other concern regarding the evaluation is the relative rapidity with which follow-up measures were collected. The primary data collection through the establishment survey and traffic surveys occurred less than a year after completion of the construction. While these datasets are extremely relevant for identifying the impacts of the Transportation Project, they should not be considered the final word on impacts. Numerous adaptations, such as adjustments in agricultural production and distribution are likely to be implemented over a longer range of time. Similarly, it is plausible that entrepreneurial innovations in other sectors that are responsive to the decline in transportation costs can take time to be recognized, introduced, and for their effects to become apparent. Mu and Van de Walle (2007) provide evidence on the importance of allowing sufficient time to pass to assess impacts. They identify minimal effects two years after construction is concluded but more significant changes within five years.

The benefits of reexamining project outcomes at a later date should be weighed against additional costs. One low cost approach to reexamining project impacts would make use of MTI road count data. The existing rate of return calculations are based on the MTI traffic counts and are structured flexibly so that annual updates can be made when additional data becomes available.

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Appendix A: Scope of Work

Section E. of the Scope of Work outlines the methodology used in the analysis and is excerpted below.

MCC has developed the following approach for the analysis.

Evaluation Approach: Project beneficiaries are households in communities affected by the Secondary Road Activity. The evaluation approach is a double difference comparison. The double difference is comprised of:

1. First difference: comparing availability and prices of goods in communities affected by the upgrading **before and after** the upgrading.
2. Second difference: comparing availability and prices of goods in communities NOT affected by the upgrading **before and after** the upgrading to those communities in point 1 above.

The double difference comparison can also be represented by the following equation:

- Change in price due to road upgrading = $(Price_{X2} - Price_{X1}) - (Price_{Y2} - Price_{Y1})$
    - X is community affected by upgrading
    - Y is community NOT affected by upgrading
    - 1 is price Before upgrading; and
    - 2 is price After upgrading

Data collection: Data collection will be done by an entity currently contracted by MCA-N. The baseline data was comprised of a price survey in 30 communities; approximately 15 communities affected by upgrades and 15 communities not affected by upgrades. The price survey was comprised of a basket of consumption goods and may also include prices of productive inputs. The survey was repeated in the same communities post road upgrading in the fall of 2010. In addition, the group of 15 communities affected by upgrades includes communities different distances from the road. This stratification was done to understand whether and to what degree impact diminishes as distance to the road increases.

The consultant will analyze both the baseline data and the post-upgrading data to produce an impact analysis.

Appendix B: Establishment Survey Treatment and Control Communities

Departamento	Dep_no	Municipio	Mun_no	Comunidad	Com_no	Carratera	Treatment
CHINANDEGA	30	SAN PEDRO DEL NORTE	5	EL CHAPARRAL	9	S5	0
CHINANDEGA	30	SAN PEDRO DEL NORTE	5	EL POLVON	14	S3	0
CHINANDEGA	30	SAN PEDRO DEL NORTE	5	SAN PEDRO DEL NORTE - URBANO	26	S3	0
CHINANDEGA	30	SAN FRANCISCO DEL NORTE	10	EL UBUTO	33	S2	0
CHINANDEGA	30	SAN FRANCISCO DEL NORTE	10	LOS PLANCITOS	39	S2	0
CHINANDEGA	30	SAN FRANCISCO DEL NORTE	10	SAN FRANCISCO DEL NORTE-URBANO	40	S2	0
CHINANDEGA	30	CINCO PINOS	15	EL CERRO	44	S3	0
CHINANDEGA	30	CINCO PINOS	15	LA HONDA	52	S1	1
CHINANDEGA	30	SANTO TOMAS DEL NORTE	20	LAS UVAS	62	S1	1
CHINANDEGA	30	SANTO TOMAS DEL NORTE	20	SANTO TOMAS DEL NORTE	67	S1	1
CHINANDEGA	30	SANTO TOMAS DEL NORTE	20	VILLA CAMILO ORTEGA	68	S1	1
CHINANDEGA	30	SOMOTILLO	35	LOS LIMONES	127	S1	1
CHINANDEGA	30	SOMOTILLO	35	SAN ANTONIO	129	S3	1
CHINANDEGA	30	VILLANUEVA	40	LA CONCEPCION	142	S4	0
CHINANDEGA	30	VILLANUEVA	40	LA PITAHAYA	143	S4	0
CHINANDEGA	30	VILLANUEVA	40	LOS LAURELES	144	S4	0
CHINANDEGA	30	VILLANUEVA	40	VILLANUEVA URBANO	156	S4	1
LEON	35	ACHUAPA	5	ACHUAPA-URBANO	195	S5	0
LEON	35	EL SAUCE	10	EL BEJUCO	218	S5	0
LEON	35	EL SAUCE	10	LAS PILAS	226	S5	0
LEON	35	LEON	40	CARLOS CANALES	295	S9	1
LEON	35	LEON	40	CHACARASECA	296	S6	0
LEON	35	LEON	40	LA CEIBA	312	S9	1
LEON	35	LEON	40	LA PENITAS	319	S9	1
LEON	35	LEON	40	LOC .LOMA PELADA	324	S6	0
LEON	35	LEON	40	PONELOYA	338	S9	1
LEON	35	LEON	40	SAN ROQUE	345	S9	1
LEON	35	LEON	40	SANTA TERESA	349	S6	0
LEON	35	NAGAROTE	50	EL COBANO	368	S13	0
LEON	35	NAGAROTE	50	EL PAPALOTE	369	S13	0
LEON	35	NAGAROTE	50	LOC. LAS RUEDAS	371	S13	0
LEON	35	NAGAROTE	50	PUERTO SANDINO	375	S13	0
LEON	35	NAGAROTE	50	VILLA OPERADORAS	385	S13	0

Appendix C : Establishment Survey Detailed Results

Price changes and price variability at the establishment level (Specification 2). The number associated with each price (p) or standard deviation (sd) represents a specific good in the Canasta Basica as indicated by the item code in Table 45.

Panel 1: Staple Foods

Variable	p1	sd1	p2	sd2	p3	sd3	p4	sd4
Treat	-0.1152	-0.1402	2.1113	-0.3919	0.1448	-0.0992	-0.4725	-0.5974
	0.2813	0.2568	0.0000	0.4757	0.2818	0.6673	0.3013	0.3391
Year	-0.5000	-0.0537	-1.7353	0.9886	0.8621	0.5233	-9.0197	0.5649
	0.0000	0.6270	0.0000	0.0731	0.0000	0.0169	0.0000	0.3289
TreatXYear	-0.0121	0.1117	-1.6591	-0.2282	-0.6017	-0.2363	0.6142	0.0232
	0.9426	0.5535	0.0156	0.8032	0.0050	0.5097	0.4045	0.9806
Urban	0.2372	0.3392	-1.0270	-0.0754	-0.0632	0.3934	-1.5557	0.5504
	0.0041	0.0017	0.0016	0.8721	0.5447	0.0500	0.0000	0.2991
TreatXYearXUrb	0.0410	-0.1916	1.8511	1.5437	0.2535	0.1508	0.4506	0.9315
	0.7989	0.3847	0.0091	0.1418	0.2247	0.7215	0.5299	0.4106
Constant	10.3291	0.5655	13.6830	1.2026	5.8321	0.1445	39.7887	2.0650
	0.0000	0.0000	0.0000	0.0030	0.0000	0.3657	0.0000	0.0000
r2	0.1155	0.2090	0.2984	0.2453	0.1052	0.2319	0.6137	0.1238
N	504	56	267	40	540	57	509	56

Panel 2: Meats

Variable	p5	sd5	p6	sd6	p7	sd7	p8	sd8
Treat	-0.2126	0.5055	-0.3273	-0.2673	-0.0348	0.1245	-4.2648	-3.5051
	0.8869	0.6215	0.7891	0.7487	0.9046	0.5874	0.128	0.212
Year	0.187	-0.8105	4.7768	0.5281	-0.4107	-0.0302	-1.8219	-2.6391
	0.8292	0.3177	0	0.5293	0.1083	0.8863	0.3881	0.2562
TreatXYear	-6.798	-2.0722	1.5775	0.3384	-0.3309	-0.0485	33.8128	3.6997
	0.0043	0.2165	0.4589	0.8078	0.4575	0.881	0	0.2591
Urban	-0.9839	-0.3765	3.0316	0.7253	-0.0987	0.2734	0.6575	3.5051
	0.3837	0.6636	0.0064	0.3269	0.6693	0.134	0.7998	0.212
TreatXYearXUrb	6.8839	1.3868	-3.0316	-1.786	-0.3699	**0.7285**	-29.9075	
	0.0022	0.3271	0.3126	0.3166	0.3621	**0.0409**	0	
Constant	36.8235	2.3772	28.9729	0.4613	23.705	0.6228	22.274	0
	0	0.0092	0	0.5761	0	0.0019	0	1
r2	0.1489	0.2908	0.399	0.1812	0.0854	0.34	0.7432	0.6888
N	105	23	62	18	255	40	24	7

Panel 3: Dairy and Eggs

Variable	p9	sd9	p10	sd10	p11	sd11
Treat	-1.1889	-0.7191	1.5868	0.2696	3.6875	-0.3903
	0.3674	0.7884	0.2145	0.8894	0.1101	0.8883
Year	2.3267	2.5161	-1.2003	7.9402	-1.0344	0.4036
	0.0214	0.2414	0.3552	0.0001	0.5824	0.8891
TreatXYear	0.1937	2.7380	-4.7670	-0.4627	-8.7670	**10.4105**
	0.9274	0.5138	0.0206	0.8753	0.0217	**0.0450**
Urban	1.7415	1.3695	-1.3480	0.4133	-2.0279	-0.6859
	0.0696	0.5073	0.1842	0.7900	0.2108	0.7674
						-
TreatXYearXUrb	-0.0843	-3.8324	7.1359	-4.3449	8.8766	**9.5304**
	0.9606	0.2807	0.0001	0.1589	0.0150	**0.0510**
Constant	15.8685	0.4650	30.9694	1.3728	30.9711	4.0323
	0.0000	0.8084	0.0000	0.3441	0.0000	0.0869
r2	0.1080	0.2249	0.0592	0.4767	0.1093	0.3936
N	134	19	366	40	103	22

Panel 5: Produce

Variable	p16	sd16	p17	sd17	p18	sd18	p19	sd19
Treat	-1.8340	0.7078	-0.1798	-0.0578	15.2641	0.0519	-1.3527	-1.1796
	0.0029	0.2575	0.8701	0.9647	0.0000	0.9793	0.4241	0.3643
Year	1.4734	0.9317	4.4667	2.2684	1.7527	2.3222	-0.3682	-0.8045
	0.0123	0.1150	0.0000	0.0628	0.4616	0.2059	0.6186	0.3798
TreatXYear	1.6526	-1.2457	0.2225	0.4394	-9.4443	0.6005	-1.9673	(omitted)
	0.0975	0.1939	0.8948	0.8242	0.0283	0.8410	0.5464	
Urban	0.9240	1.2115	-2.9802	1.1657	-4.1761	1.2987	-1.8354	(omitted)
	0.0637	0.0183	0.0005	0.2709	0.0509	0.4139	0.2822	
TreatXYearXUrb	-1.2874	-0.7101	2.6560	-0.6565	7.7378	5.0732	1.6854	(omitted)
	0.1828	0.4960	0.0999	0.7663	0.0629	0.1247	0.5902	
Constant	9.5774	2.0509	13.4060	3.5741	54.4042	4.1659	6.1882	1.8867
	0.0000	0.0001	0.0000	0.0005	0.0000	0.0068	0.0011	0.0307
r2	0.0926	0.2003	0.1718	0.1621	0.1553	0.2619	0.0951	0.2717
N	336	44	349	48	323	45	46	7

Panel 5, part 2: Percederos

Variable	p20	sd20	p21	sd21	p22	sd22	p23	sd23
Treat	-0.0967	1.0658	1.1529	0.1113	0.4171	-0.7836	2.5128	0.7476
	0.9517	0.7551	0.0000	0.6871	0.5754	0.4687	0.0159	0.7217
Year	14.1840	8.6153	0.1009	0.3638	0.1709	1.0925	3.2557	2.0361
	0.0000	0.0096	0.6489	0.1682	0.7793	0.2676	0.0017	0.3565
TreatXYear	1.4367	-2.7744	0.3728	-0.1144	1.2309	-0.9554	2.9313	1.8591
	0.6053	0.5962	0.3705	0.7934	0.5277	0.5014	0.2043	0.6180
Urban	0.9660	6.7549	1.7052	0.5291	0.9313	0.7342	1.6002	0.6339
	0.4761	0.0167	0.0000	0.0229	0.2783	0.5100	0.0991	0.7285
TreatXYearXUrb	-2.6603	-0.4768	-0.9545	0.0997	-0.8934	(omitted)	-2.4375	1.7512
	0.3264	0.9322	0.0158	0.8193	0.6326		0.2993	0.6264
Constant	16.6978	0.2152	3.3972	0.3439	3.8151	0.8682	3.3788	0.4956
	0.0000	0.9341	0.0000	0.1489	0.0000	0.4235	0.0005	0.7866
r2	0.3291	0.3265	0.3087	0.3032	0.0481	0.3018	0.2009	0.2939
N	317	42	272	32	85	15	163	28

Panel 6: Household goods

Variable	p24	sd24	p25	sd25	p26	sd26	p27	sd27
Treat	-0.1291	0.0132	-1.8272	-0.4543	0.5615	0.5079	0.0319	0.0319
	0.5952	0.9726	0.0000	0.3040	0.1656	0.5304	0.4476	0.7551
Year	0.8407	0.7522	-2.0289	0.3237	1.6726	1.5254	0.1002	0.2006
	0.0000	0.0244	0.0000	0.4175	0.0000	0.0360	0.0101	0.0380
TreatXYear	-0.5344	0.2112	1.9065	0.0172	-1.1822	0.3621	-0.0743	-0.1340
	0.1486	0.7107	0.0004	0.9792	0.0593	0.7633	0.2772	0.3956
Urban	-0.3038	0.0227	0.4450	0.5478	0.3906	0.3257	0.0178	0.1760
	0.0915	0.9406	0.0882	0.1354	0.2030	0.6181	0.5882	0.0464
TreatXYearXUrb	1.1138	-0.2954	-0.5088	-0.1603	0.5480	-1.2642	-0.0196	-0.0934
	0.0010	0.6449	0.2831	0.8348	0.3471	0.3600	0.7666	0.6147
Constant	12.8719	0.8901	4.2109	0.6683	21.5939	0.9419	0.9995	-0.0025
	0.0000	0.0008	0.0000	0.0354	0.0000	0.0944	0.0000	0.9719
r2	0.0982	0.1826	0.1212	0.1092	0.0692	0.1663	0.0129	0.1597
N	457	53	451	54	449	53	569	56

Panel 6, part 2: Household Goods

Variable	p28	sd28
Treat	-0.9774	-0.0542
	0.1833	0.9613
Year	3.5774	0.6582
	0.0000	0.4772
TreatXYear	-4.5322	0.8481
	0.0013	0.6776
Urban	-0.9663	-0.1496
	0.1226	0.8563
TreatXYearXUrb	3.6574	-1.3242
	0.0054	0.5167
Constant	31.7988	2.7551
	0.0000	0.0016
r2	0.1913	0.0510
N	272	34

Panel 6, part 3: Household Goods

Variable	p29	sd29	p30	sd30	p31	sd31	p32	sd32
Treat	-0.1700	0.1503	-0.3886	0.1052	-0.4650	0.2973	-0.5913	2.8791
	0.3460	0.4740	0.0098	0.5594	0.0568	0.4234	0.6604	0.1679
Year	2.0035	0.7047	2.0402	0.3016	1.9821	-0.0163	2.1285	2.5186
	0.0000	0.0004	0.0000	0.0688	0.0000	0.9621	0.0644	0.1689
TreatXYear	-0.5626	**-0.7907**	0.1349	-0.2345	0.7238	**-1.0434**	1.6105	-4.1448
	0.0574	**0.0166**	0.6060	0.3887	0.0721	**0.0594**	0.4240	0.1449
Urban	-0.1998	0.6801	0.2505	0.1948	0.4453	0.1436	1.8715	-2.5737
	0.1599	0.0003	0.0398	0.1935	0.0203	0.6311	0.0862	0.0996
TreatXYearXUrb	0.2057	-0.3014	0.0499	0.0606	-0.6383	0.3873	0.6748	0.9872
	0.4688	0.4221	0.8445	0.8472	0.0974	0.5325	0.7198	0.7274
Constant	8.6041	0.5173	10.8715	0.6780	11.7358	1.3992	42.0560	4.5936
	0.0000	0.0005	0.0000	0.0000	0.0000	0.0000	0.0000	0.0138
r2	0.3014	0.4133	0.4856	0.1137	0.2814	0.1573	0.0699	0.1983
N	556	56	475	54	467	50	268	36

Panel 6, part 4: Household Goods

Variable	p33	sd33
Treat	-0.1264	0.2252
	0.4707	0.3331
Year	0.7735	0.6889
	0.0000	0.0025
TreatXYear	-0.1718	**-1.1619**
	0.5749	**0.0019**
Urban	-0.1290	0.0442
	0.3759	0.8191
TreatXYearXUrb	0.1895	0.3883
	0.5152	0.3412
Constant	8.9247	0.7338
	0.0000	0.0000
r2	0.0818	0.2693
N	460	52

Panel 7: Utilities

Variable	p34	p35	p36	p37	p38
Treat	-227.0305	-32.5176	0.0115	45.1684	-10.3470
	0.0000	0.0000	0.6165	0.0000	0.0000
Year	6.4352	2.9927	0.0393	-4.8838	-0.2535
	0.8111	0.5743	0.0599	0.5596	0.8713
TreatXYear	154.8047	-9.4785	-0.0511	54.2203	3.4346
	0.0057	0.3158	0.1712	0.0008	0.2209
Urban	498.8605	23.7824	0.0548	37.9294	-1.9655
	0.0000	0.0000	0.0028	0.0000	0.1527
TreatXYearXUrb	-229.2539	24.3438	0.0175	-81.2497	-5.9091
	0.0000	0.0121	0.6383	0.0000	0.0347
Constant	706.6600	248.9360	4.5281	42.4495	33.0691
	0.0000	0.0000	0.0000	0.0000	0.0000
r2	0.4489	0.1514	0.0210	0.1022	0.091429
N	651	751	842	768	842

Panel 8: Men's Clothing 1

Variable	p39	sd39	p40	sd40	p41	sd41	p42	sd42
Treat	11.6469	8.9534	18.3743	2.5299	-3.1244	-3.1874	-1.2902	1.1397
	0.2663	0.3202	0.1335	0.7735	0.0168	0.0395	0.0228	0.0630
Year	23.9268	11.6463	41.1282	-6.4575	-0.1743	1.3447	-0.5519	0.8763
	0.0012	0.1046	0.0000	0.3723	0.8797	0.3348	0.2506	0.0939
TreatXYear	-13.9062	-8.0633	7.5396	13.0688	2.0921	2.4569	2.3111	2.0011
	0.4465	0.5752	0.7485	0.4550	0.3576	0.3958	0.0421	0.0780
Urban	-5.5234	12.9621	11.0926	23.9812	0.0244	1.1385	-0.9732	0.4681
	0.5656	0.0728	0.3633	0.0058	0.9822	0.3405	0.0361	0.3055
TreatXYearXUrb	29.0949	10.4422	-29.5240	6.3210	1.7742	0.2165	-1.1375	-2.0173
	0.1110	0.4762	0.2009	0.7146	0.4244	0.9422	0.2979	0.0715
Constant	179.4039	5.0526	94.6246	10.0942	17.2691	4.2488	14.1560	0.5835
	0.0000	0.4666	0.0000	0.1740	0.0000	0.0008	0.0000	0.1774
r2	0.1967	0.4402	0.2064	0.5817	0.0398	0.3092	0.0676	0.5028
N	120	21	120	19	222	31	189	32

Panel 8, part 2: Men's Clothing 2

Variable	p43	sd43
Treat	-5.1000	-6.9430
	0.8623	0.8434
Year	98.2941	5.1993
	0.0000	0.8650
TreatXYear	-13.5588	15.6314
	0.8299	0.8137
Urban	24.4176	27.6840
	0.3857	0.3812
TreatXYearXUrb	-87.9176	26.5667
	0.1790	0.7019
Constant	260.3647	42.6809
	0.0000	0.2188
r2	0.3086	0.1989
N	78	18

Panel 8, part 3: Women's Clothing

Variable	p44	sd44	p45	sd45	p46	sd46	p47	sd47
Treat	3.4284	-7.4820	20.7671	8.9625	-39.0000	-56.5685	-0.9856	-1.1927
	0.7519	0.5899	0.1172	0.5403	0.4711	0.3217	0.3753	0.4541
Year	32.4808	-4.8383	24.4404	25.6825	1.2778	20.3871	2.6455	1.8384
	0.0002	0.6791	0.0063	0.0473	0.9706	0.6226	0.0030	0.1607
TreatXYear	-11.9227	18.4249	22.8774	21.8408	-39.6111	25.8009	-3.0556	-0.9398
	0.5410	0.4378	0.2491	0.3444	0.6364	0.7146	0.0991	0.7168
Urban	1.7565	-2.7706	17.3614	8.8818	-115.0000	(omitted)	0.8863	1.1107
	0.8626	0.7983	0.1545	0.4630	0.1642		0.2889	0.3418
TreatXYearXUrb	1.0324	7.0394	-12.0836	-44.7731	104.3333	45.6270	3.2979	2.1528
	0.9566	0.7523	0.5685	0.0669	0.2738	0.4580	0.0573	0.4104
Constant	94.6245	39.2707	169.1373	6.9275	304.0000	56.5685	17.0519	2.6880
	0.0000	0.0012	0.0000	0.6054	0.0017	0.1521	0.0000	0.0223
r2	0.1136	0.1076	0.2099	0.4028	0.1437	0.6821	0.0939	0.1870
N	151	25	124	22	26	7	245	36

Panel 8, part 4: Women's Clothing 2

Variable	p48	sd48	p49	sd49
Treat	2.8171	-0.1170	5.0742	-11.5270
	0.1564	0.9352	0.8157	0.6343
Year	2.8427	-0.4688	-3.9244	-12.4511
	0.0734	0.6987	0.7984	0.5673
TreatXYear	-4.4598	-0.1912	14.1885	41.5332
	0.1679	0.9348	0.7052	0.3190
Urban	-0.9304	1.1022	5.7663	23.2559
	0.5381	0.3074	0.7696	0.2739
TreatXYearXUrb	1.2964	0.9121	-25.0800	-41.1336
	0.6694	0.6968	0.4994	0.3405
Constant	24.1125	2.7173	141.3284	47.2873
	0.0000	0.0174	0.0000	0.0341
r2	0.0196	0.0788	0.0058	0.1243
N	227	34	112	20

Panel 8, part 5: Children's clothing

Variable	p50	sd50	p51	sd51	p52	sd52	p53	sd53
Treat	27.3812	10.9526	-0.5848	-1.1518	0.1220	-0.3107	5.7306	-8.6802
	0.0396	0.4667	0.2763	0.2216	0.8179	0.6371	0.8734	0.7704
Year	30.2088	11.6868	1.5150	0.1803	1.0058	0.2576	19.6248	-6.7442
	0.0033	0.3418	0.0010	0.8191	0.0257	0.6372	0.5435	0.8327
TreatXYear	-31.6780	24.1571	0.2184	1.7360	-0.0391	1.3351	81.0355	55.5548
	0.1682	0.3383	0.8235	0.2593	0.9657	0.2329	0.1638	0.3018
Urban	29.2537	11.3939	0.5406	0.3960	0.3039	0.8103	60.1193	48.0019
	0.0187	0.3133	0.2076	0.5772	0.4676	0.1066	0.0813	0.1417
TreatXYearXUrb	-13.9883	-33.4198	-0.4127	-0.6460	-0.3726	-0.3907	-65.1193	0.7065
	0.5288	0.1884	0.6603	0.6794	0.6650	0.7210	0.2961	0.9889
Constant	95.9380	22.8837	9.8826	2.1379	10.2551	0.8104	121.9424	25.9941
	0.0000	0.0496	0.0000	0.0012	0.0000	0.0768	0.0010	0.4058
r2	0.0965	0.2358	0.0781	0.0832	0.0324	0.2050	0.1256	0.4467
N	153	25	264	40	226	35	57	15

Item availability analysis: Significant differences in changes in counts by group

	By Year				By Treatment			
Grp.	Cont_urb	Cont_rur	Trt_urb	Trt_rur	08_urb	08_rur	10urb	10rur
1	0.031	0.056	0.075*	0.054	0.054	0.024	0.098**	-0.086*
2	0.030	0.064**	0.200	0.050**	-0.023	0.003	-0.034	-0.011
3	0.121**	0.067*	0.051	0.022	0.212**	0.008	0.141**	0.037
4	0.164**	0.189**	0.159**	0.106**	0.131**	0.015	0.127**	-0.068**
5	0.052	0.060*	0.001	0.021	0.023	-0.003	0.077*	0.042
6	0.130**	0.179**	0.126**	0.045	0.116*	0.013	0.113**	-0.121**
7	-	-	-	-	-	-	-	-
8	0.027	0.024	0.085**	-0.028	-0.090**	0.035	-0.031	-0.016

Group variable is defined in the Canasta Basica: (1) staple foods (2) meat, fish, and poultry, (3) dairy and eggs, (4) cereals, (5) produce, (6) household costs, (7) household rent and utilities, and (8) clothing. Note that item (7) was not collected at the establishment level.

Appendix D: RBD Survey Treatment Estimates

RBD: Per capita expenditure changes based on household surveys conducted in 2007 and 2011. Model 1 includes households in treatment and control communities according to the narrow definition used in the establishment survey. Model 2 includes households in a broader zone of influence; households within 30 minutes of treatment and control roads are included. Model 3 includes all observations in the dataset, while maintaining the same treatment definition as model 2.

Variable	PCExp1	PCExp2t	PCExp3
_Iyear_1	4130.8265	2564.3378	2264.4494
	0.0035	0.0003	0.0000
_Itrt_1	8839.8789	1766.6914	4659.4405
	0.5930	0.8185	0.4602
IyeaXtrt~1	-9738.1164	-2823.6597	-2139.3323
	0.0487	0.0728	0.1144
_Iurban_1	2899.2184	3688.2508	5784.4373
	0.2884	0.0215	0.0000
_Itr_Xurb_~1	1864.6133	10024.952	7203.7538
	0.8439	0.0024	0.0224
hhsize	-1513.8603	-1574.4926	-1470.0436
	0.0000	0.0000	0.0000
_cons	97193.014	104277.55	39387.936
	0.0000	0.0000	0.0000
[Household Characteristics and Community Fixed Effects Omitted]			
chi2	482.51206	976.85265	1524.6819
r2_o	.66232542	.51237217	.39287888
N	297	1082	3103

RBD: Fischer Food Quantity Index Results

Variable	q1_XT_trtd	q2_XT_trtd	q3_XT_trtd	q4_XT_trtd	q5_XT_trtd	q_XT_trtd
_Itrt_dist_1	-.47944939	-.54179591	19.395078	2.5159252	-.59330652	.44684162
	0.8615	0.8073	0.0003	0.7741	0.8669	0.9490
_Iurban_1	.16170485	-.89000262	-3.3463171	-1.3152048	-.02176594	-.22886938
	0.7443	0.0343	0.0043	0.4172	0.9692	0.8417
ItrtXurb~1	.81346668	.61829291	2.4251679	1.7317252	.15972319	.5261135
	0.2772	0.3233	0.1798	0.4993	0.8512	0.7715
[Household characteristics and community fixed-effects omitted]						
_cons	1.9289379	.31046446	1.833146	-.58217105	3.4421258	1.0829667
	0.4854	0.9103	0.5302	0.9310	0.1669	0.8734
r2	.23280139	.25793351	.61832013	.2830497	.13771503	.0820293
N	478	365	184	440	490	537

RBD: Aggregate annual transportation expenditures, panel data DD estimates

Variable	Trans_exp1	Trans_exp2	Trans_exp3
_Iyear_1	1078.8164	200.56638	-386.1606
	0.0882	0.6464	0.0771
_Itrt_1	3277.593	-3355.7491	-671.50697
	0.3310	0.4906	0.8353
IyeaXtrt~1	-3382.2801	-200.12206	240.38641
	0.1238	0.8375	0.7724
urban	451.69849	124.60177	434.34579
	0.7312	0.9019	0.4071
_Itr_Xurba~1	-5596.1707	2216.251	1515.8346
	0.1995	0.2824	0.4058
[Household characteristics and community fixed-effects omitted]			
_cons	-4424.3901	-1939.9711	4537.3743
	0.3258	0.7114	0.0497
chi2	49.498344	93.133235	267.98637
r2_o	.17519608	.0930507	.08991307
N	295	1082	3103

Aggregate annual health care expenditures, panel data DD estimates

Variable	Health exp1	Health exp2	Health exp3
_Iyear_1	1231.0353	1488.2468	2491.4604
	0.6820	0.3994	0.0189
_Itrt_1	-3505.1833	-2029.5912	12393.784
	0.8315	0.9150	0.4134
IyeaXtrt~1	-18783.741	-9751.7944	-11094.177
	0.0713	0.0135	0.0060
urban	1955.4311	6739.124	2373.2605
	0.7612	0.0897	0.3362
_Itr_Xurba~1	-28349.587	-5528.993	-586.27313
	0.1758	0.5026	0.9465
[Household characteristics and community fixed-effects omitted]			
_cons	-20606.251	-13513.324	-8850.3076
	0.3515	0.5096	0.4177
chi2	53.773784	168.27733	397.58976
r2_o	.18866636	.150805	.12386045
N	295	1082	3103

Appendix E: Response to Reviewers

Reviewer feedback on the evaluation report has been valuable, containing both useful suggestions for specific changes in the estimation and presentation of core findings and broader methodological discussion. Several of the synoptic comments on the methodology mirror discussion already in the document identifying limitations of the establishment survey approach. The difficulty of connecting the establishment price surveys directly to welfare measures is highlighted in the executive summary and in the conclusion of the document. However, the remarks of both Osborne and Jacoby contain suggestions that can add value to the establishment surveys. Their proposals suggest implementing followup surveys that continue to track price and availability of goods, while augmenting the surveys to also identify the location of origin of specific goods. As noted by Osborne, the extension of the establishment survey methodology "would allow one to examine differences in prices for "imported" versus "exported" goods from specific geographic areas, and by the fraction of the trip improved under the project."

Other recommendations include conceptual approaches that are quite different from the establishment survey methodology and also have merit. Given the relatively rapid timetable for the evaluation after completion of road rehabilitation, reviewers recommended examining data that sheds light on intermediate rather than final outcomes. The suggestion to examine market power and pricing in the transportation sector seems especially valuable for generating additional insight on the impact of the VG road that carries significant international traffic and trade. It should be noted that these approaches require additional data and methods that go beyond those identified in the scope of work of the project.

Modifications to the evaluation text in response to referee suggestions include the introduction of better specified error component models to capture correlation across towns along the same roadways, as well as a variety of clarifications that include better explication of the implications of different specifications of the presumed zone of influence of the roads, combination of some tables on product availability to avoid redundancies, and additional explanation of results particularly those related to changes in availability of goods.