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Lessons from MCC's Investments in Roads

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The Millennium Challenge Corporation's mandate is to reduce poverty through economic growth. MCC works with a select number of developing countries that demonstrate a commitment to good governance and sound economic and social policies where the opportunity for economic growth and poverty reduction is greatest. MCC's model reflects a set of principles that the United States—and many other donors and advocates—agree are required for development assistance to work well: country ownership, an evidence-based approach, focus on results, and transparency.

MCC's Principles into Practice *series offers a frank look at what it takes to apply these principles in day-to-day operations. MCC hopes that capturing and sharing the experiences will help MCC and others learn and do better.* Lessons from MCC's Investments in Roads *is the ninth paper in the Principles into Practice series available at http://www.mcc.gov/p-into-p.*

This paper explores the Millennium Challenge Corporation's (MCC) experience to-date in designing, implementing, monitoring, and evaluating roads investments around the world. It offers critical lessons for the agency's roads sector — lessons that are already being applied in compacts under development and new evaluations of road activities. The analysis also draws out practical lessons for all donors seeking to maximize the development impact and cost effectiveness of road projects.

MCC's guiding principles of country ownership, accountability, and a focus on results have led the agency, together with its country partners, to develop projects totaling nearly $3 billion in the transportation sector.[1] Since MCC's creation in 2004, roughly 30 percent of its total compact investment portfolio has been devoted to projects focused on roads, making MCC one of the leading bilateral donors in the transportation sector.[2]

MCC's investments in roads have been far-reaching. The agency has built or rehabilitated 3,400 kilometers of roads in 16 countries around the world, roughly the equivalent distance from New York City to Phoenix, Arizona.[3] These road works have consisted of reconstruction of pavement, drainage, and bridges, with the majority of the projects producing paved roads and a small share applying gravel or another type of treatment. Road projects in earlier compacts mostly focused on infrastructure with a few investments incorporating policy and institutional reform activities, usually related to road maintenance. However, almost all road activities incorporated conditions precedent (CPs) that required partner countries to finance their road maintenance funds as a condition to receiving MCC funding.[4]

Why Roads?

Road investments are attractive to partner governments and donors alike because of their potential to improve access to goods, services, markets, and information. The logic behind improving the quality and availability of roads is simple: better roads reduce both transportation costs and travel times for producers and consumers, saving road users money and allowing more time for productive and leisure activities. Both time and cost savings also allow for greater access to social services, like schools and health centers, facilitating long-term improvements in health and education when other

1 Portfolio data based on December 2016 financial reports.

2 MCC calculations using U.S. foreign assistance data from *https://explorer.usaid.gov/data.html*, and Organization for Cooperation and Development (OECD)-Creditor Reporting System (CRS) data from *https://stats.oecd.org/Index.aspx?DataSetCode=CRS1*, accessed on August 2, 2017.

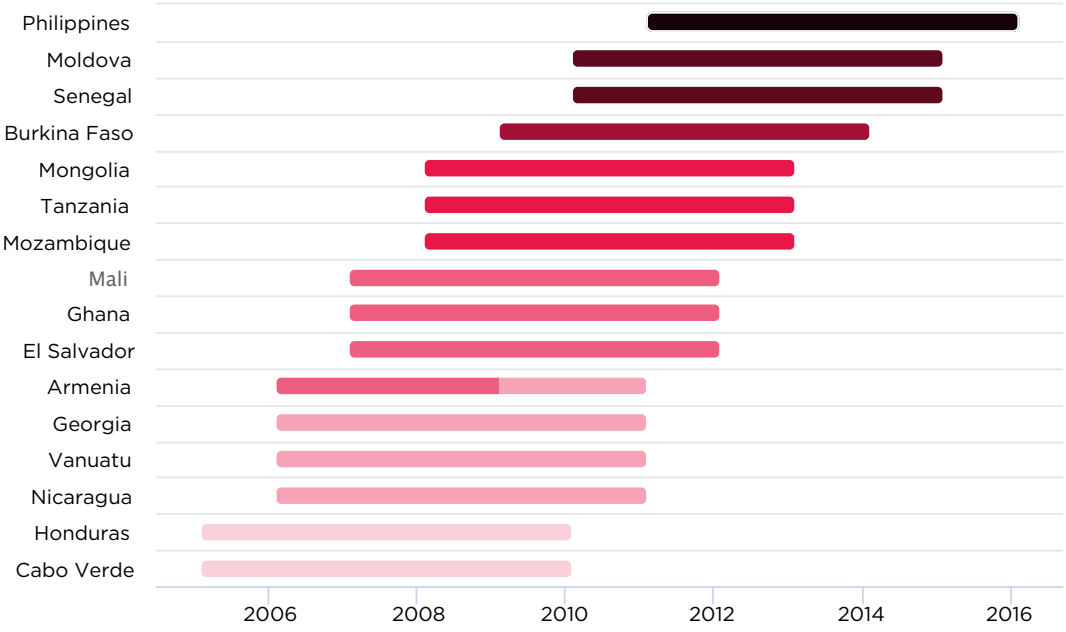
3 Based on March 2017 reporting of roads common indicators.

4 Conditions precedent (CPs) are requirements of partner governments, usually related to policy, that are tied to disbursements and must be met within a specific timeframe. If the agreed CPs are not satisfied, compact disbursements may be withheld.

necessary conditions are in place. Finally, roads can reduce isolation, allowing better flows of information, goods, and services, and improving connectedness. Realizing the full benefits of these projects, however, relies on the interaction of transportation markets with other markets. In other words, the benefit of investing in a road comes not just from having a better road, but also from the way in which that road improves other aspects of people's lives.

Indeed, challenges related to poor road infrastructure and high transportation costs comprise one of the most common barriers to economic growth as identified through MCC's analyses of the constraints to economic growth. Of the 30 constraints analyses[5] that MCC has undertaken with partner countries since 2007, 16 have identified the transport sector as a binding constraint to growth.

Figure 1. MCC Road Project Implementation Timelines



This paper draws lessons for improving MCC's approach to road projects from 16 compacts with road investments that were implemented between 2005 and 2016 (Figure 1).[6]

5 MCC conducts a constraints analysis to identify the binding constraints to economic growth in a country. This analysis follows the Hausmann, Rodrik, and Velasco (HRV) Growth Diagnostics framework.

6 The El Salvador Investment Compact and the Liberia Compact entered into force in 2015 and 2016, respectively, and both include road investments. As these road projects are still in an early stage, they are not discussed in this paper.

Key Lessons from MCC's Road Investments

MCC has identified seven key lessons from its experience investing in roads. These lessons span all three phases of the MCC compact cycle — project development, implementation, and evaluation.

1. *Understand the specific problem that a road investment aims to resolve and let that problem articulation inform project development*
2. *Prioritize and select projects based on a road network analysis*
3. *Address policy and institutional issues in the transport sector up front to ensure sustainability of road investments*
4. *Develop guidelines to promote consistent application of economic analysis tools across road projects*
5. *Require enhanced design review for road investments throughout the project lifecycle to better manage completion risk and improve investment value*
6. *Standardize the content and quality of road data collection across road projects*
7. *Better balance cost and the potential for learning when designing road project evaluations*

How MCC Chooses Road Investments

Before MCC adopted the constraints analysis approach in 2007, MCC's investments in the roads sector were based on partner country preference for such an investment, supported by due diligence studies of technical and cost parameters, and assessments of potential risks and benefits. With the use of constraints analysis as a tool for focusing compact programs on the most binding constraints to economic growth, transport — and roads in particular — often emerged as a key constraint.

Pursuant to MCC's compact development process prior to 2016, once MCC and a partner country identified transport as a sector of focus, partner governments submitted proposals for projects that would alleviate the constraints to economic growth posed by transportation infrastructure and institutions. More recently, however, MCC and partner governments have invested more time up front to first investigate the specific problems driving the transport constraint. With this foundation, projects that are designed to address one or more of those problems are then proposed.

MCC's approval of each road project has always been informed by a cost-benefit analysis (CBA) that projects economic benefits based on reductions in vehicle operating costs and passenger time (referred to hereafter as vehicle operating cost and travel time savings, or VOCTTS). The CBA compares the projected costs of the project with the projected benefits in order to generate an expected economic rate of return (ERR). Project proposals are expected to generate an adequate ERR, generally above 10 percent.

To assess the success of MCC's road investments in achieving the intended results, each one undergoes an independent evaluation to measure whether targeted outcomes were realized. These evaluations also aim to produce learning that will help the agency and interested stakeholders improve future road projects. MCC has completed road investment evaluations for projects in Armenia,[7] El Salvador, Georgia, Honduras, Nicaragua, Vanuatu, and 10 more are in progress. The completed evaluations are publicly available on the MCC Evaluation Catalog.[8]

A Review of MCC's Roads Portfolio

As MCC's early roads projects and their evaluations came to a close, the agency began a review to assess the portfolio's practices and results and identify areas for improvement. The review was three-fold, examining MCC's operations, analytics, and results (as captured by its independent evaluations). In undertaking the review, MCC sought to drive both more efficient use of agency resources and better results for beneficiaries in its partner countries. The review recognized that while evaluations can provide valuable information on project outcomes, successes, and challenges, they do not answer every question the agency and its stakeholders might have. Thus, the review aimed to integrate evaluation results with lessons learned from operational and analytical practices to allow MCC to improve the quality of its work based on the richest conclusions possible.

7 In 2009, MCC discontinued road construction and rehabilitation under the compact due to concerns about the status of democratic governance in Armenia. As a result, 25 kilometers of pilot roads were completed using MCC funding, while approximately 175 kilometers of the roads originally planned under the Armenia compact were completed with funding provided by the World Bank. MCC took the decision to continue the evaluation to take advantage of the learning opportunity, despite the fact that the majority of the investments were no longer funded by MCC.

8 MCC Evaluation Catalog, *https://data.mcc.gov/evaluations/index.php/catalog*.

MCC Road Operations

MCC's operational review considered internal processes for estimating costs, anticipating and addressing risk, and ensuring the sustainability of road investments. MCC found that, over the course of design and implementation, the costs of large infrastructure investments — particularly roads — frequently escalated above the estimates produced during compact development. This often led to MCC reducing the scope of the project to remain within budget (often referred to as de-scoping) or required a reallocation of compact resources to increase project funding, both of which decreased the benefits relative to costs of the investment. MCC also found that unanticipated risks related to resettlement and contractor performance affected implementation of road projects and, therefore, warranted better risk identification and mitigation plans up front. Lastly, MCC noted that the use of CPs to incentivize road maintenance and ensure the sustainability of road investments was not universally effective, and instead, a programmatic approach to improve maintenance may be required.

Costs

To better understand instances of cost overruns and the associated cost-quality tradeoffs, MCC conducted a study of road construction costs across its portfolio in early 2014. The study, based on 13 road compacts,[9] found that final costs were on average 135 percent higher than initially estimated.[10] On average, these projects were also reduced in scope by 33 percent between the time initial targets were set and the project was completed. MCC was not alone in experiencing this challenge; the World Bank experienced similar escalations in cost during the construction phase despite a different operational model.[11]

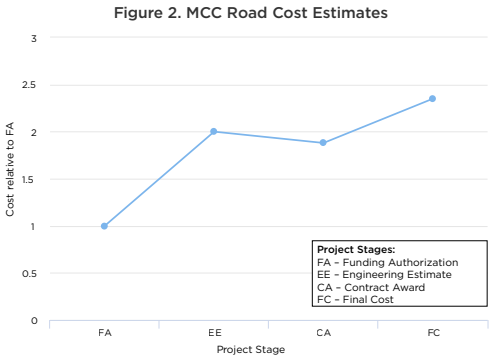


Figure 2. Road cost estimates at four project stages relative to costs at the funding authorization (FA) stage (Chong and Hopkins), 2016).

The cost study pointed to the role of feasibility studies in better estimating costs. As shown in Figure 2, the study found that the majority of cost increases occurred

9 The compacts included in the studies are: Burkina Faso, Cabo Verde, El Salvador, Georgia, Ghana, Honduras, Mali, Mongolia, Mozambique, Nicaragua, Senegal, Tanzania, and Vanuatu.

10 Chong, Uven and Hopkins, Omar, "An International Experience on the Evolution of Road Costs During the Project Life Cycle," Transport Policy 48 (2016) 60–66, *http://dx.doi.org/10.1016/j.tranpol.2016.02.010*. See p. 61.

11 Chong and Hopkins (2016), p. 63.

between initial funding projections (the project's funding authorization) and engineers' estimates. This finding was unsurprising, given that the approved compacts were often based on pre-feasibility studies rather than full feasibility studies. A smaller portion of the increase occurred between contract award and final cost. This pattern of under-estimating final cost improved after 2007, as MCC began basing initial funding decisions on more complete feasibility studies. In many cases, investment decisions being taken before more complete feasibility studies were available, and the fixed five-year compact implementation period,[12] contributed to uncertainty about, and pressure on, costs.

Risk

In a separate review of risks during implementation of MCC roads projects, the most frequent risks highlighted, aside from cost overruns and de-scoping, were issues with contractors, delays in implementation, and compliance with environmental and social performance (ESP) guidelines. ESP risks were noted as frequently as cost concerns, which may reflect the fact that ESP-related costs, such as resettlement, were underestimated in some roads projects. Issues pertaining to operational sustainability also came up relatively often and generally pertained to road quality, outcomes for road beneficiaries, and partner government compliance with MCC requirements.

While MCC anticipated risks and proposed mitigants during project development, these were not always perfectly aligned with the risks that ultimately materialized and most hampered project implementation. Tanzania and Senegal programs, for example, had not anticipated challenges related to resettlement or general contractor performance and delays, but these risks often arose during compact implementation. On the other hand, issues related to road maintenance, training, and funding were fairly frequent anticipated risks at the time of the investment decision but were less evident during compact implementation. Overall, while some countries anticipated and mitigated risks better than others, there seemed to be areas for improvement, such as better risk identification and mitigation planning that is informed by more systematic analysis of experiences in similar countries. These operational findings prompted MCC to re-consider its risk management approach and identify areas where MCC and partner countries could improve to better mitigate completion and quality risks.

Sustainability

MCC reviewed its experience addressing road maintenance and sustainability issues by assessing the degree to which each country implemented its compact's CPs, or policy reforms that trigger disbursement of MCC funding. Fifteen of the 16 road compacts

12 MCC's statute limits compact implementation to 5 years. This 5 year period begins once the compact enters into force. At the end of the 5 years, any unused grant funds are returned to the U.S. Government.

included one or more CPs specifically related to road maintenance.[13] Most commonly, the CPs required that road funds be fully operational and/or that maintenance budgets be fully funded. In almost all cases, these CPs were noted by MCC as having been satisfied. Yet, visual evidence collected either on post-compact site visits by MCC staff or from independent sources such as satellite data, suggest that some MCC-funded roads have deteriorated and not been properly maintained through continued investment on the part of the partner country. This, in tandem with the infrequent mention of road maintenance in quarterly risk reviews, points to a need for closer monitoring of maintenance practices during compact implementation to mitigate sustainability risks.

MCC Road Analytics

MCC sought to apply impact evaluation methods to assess its early road investments and measure household-level economic impacts, both of which were relatively uncommon practices at the time, particularly for highway improvements. As the first wave of road evaluations began to produce preliminary findings, MCC initiated a review process to assess the technical quality of these evaluations and their contribution to learning. A peer review workshop took place in September 2013 at which independent road engineering and evaluation experts assessed the methodology and preliminary analysis of six early road evaluations (Armenia, El Salvador, Georgia, Honduras, Nicaragua, and Vanuatu). The evaluations employed varying quasi-experimental[14] methodologies for impact evaluations and used modeling programs such as Highway Development and Management[15] (HDM) and Roads Economic Decision[16] (RED) for performance evaluations.[17] The road experts also examined the data and analysis that comprised some of the initial road project CBAs conducted by MCC.

On the road impact evaluations, the peer reviewers appreciated MCC's efforts to use rigorous methods to validate the economic impacts of roads, and offered a range of feedback that centered on the importance of understanding the logic or theory of change underlying a road investment prior to designing an evaluation. They underscored the challenge of designing quantitative evaluations without having a benchmark

13 Only the Philippines Compact did not include CPs specifically related to road maintenance because MCC had determined that a satisfactory road maintenance regime was already in place.

14 Quasi-experimental evaluation designs compare outcomes between the units that received the intervention (treatment group) and similar units that did not (comparison group) to assess impacts, but rely on methods other than random assignment to identify the comparison group.

15 The Highway Development and Management version 4 (HDM-4) model is an extensive and internationally recognized roads cost-benefit analysis model currently maintained by the World Bank. It was developed in the 1990s and has been continuously improved since, and is a rigorous model for measurement of vehicle operating cost and time savings for users of a road.

16 Similar to HDM-4, the Roads Economic Decision (RED) model is an internationally recognized cost-benefit analysis model developed by the World Bank. It is a simplified version of HDM-4 for use on low-traffic roads where not all road information is available.

17 MCC defines impact evaluations as those that employ a credible and rigorously defined counterfactual in order to measure changes in outcomes that are attributable to a defined intervention. Performance evaluations, on the other hand, seek to answer descriptive questions that are pertinent to program design, management, and operational decision-making but cannot claim attribution.

or target for the expected impact on outcomes of interest beyond VOCTTS. Reviewers also noted the need to carefully consider the validity of counterfactuals used in quasi-experimental designs, as the geographic area of impact from an improved road can differ depending on the context. Reviewers cautioned against defining evaluations narrowly around measuring incomes or income proxies, even though those outcomes reflect MCC's goal of poverty reduction through economic growth. Instead they advocated to focus data collection on intermediate outcomes, whose changes can likely be detected sooner than effects on incomes or consumption and which can help to identify the pathways that may result in income gains.

In reviewing the CBA models that estimated the economic benefits of road investments, reviewers offered practical suggestions for improving documentation of the models and their underlying assumptions, and creating templates to standardize reporting. Peer reviewers emphasized the need to expand and improve data collection to strengthen the reliability of key data on traffic counts, travel times, and vehicle operating costs, and to ensure that all inputs to the model are collected accurately. They also noted that additional benefits stemming from reduced injuries and emissions or exogenous social benefits could be incorporated into the models. With the peer review feedback in mind, MCC conducted further internal reviews of the CBA and evaluation work, reconsidering strategies for modeling and measuring benefits.

Independent Evaluation Results

In line with MCC's commitment to accountability and learning, each road investment has undergone or will undergo an independent evaluation that is designed and implemented by researchers external to MCC. In 2014, MCC conducted a review of the first set of completed road evaluations to synthesize findings and draw lessons for future project design and evaluation. These evaluations studied road projects in compacts with Armenia, El Salvador, Georgia, Honduras, Nicaragua, and Vanuatu, and employed differing methodologies to assess the outcomes of the projects. While outputs and immediate outcomes, such as reductions in road roughness or travel times, were generally validated by monitoring data and evaluation results, intermediate and long-term outcomes on prices of goods or household incomes proved challenging to detect. The evaluation findings are summarized below and more details are provided in Appendix A.

Armenia. The impact evaluation of the Armenia road investments, which were originally developed by MCC but subsequently implemented using World Bank loans, was intended to assess impacts on a range of immediate and long-term outcomes. Evaluators found strong positive impacts on immediate outcomes relating to perceptions of road quality, travel times, and travel costs, but impacts on long-term outcomes were limited. The evaluators noted that the one-year exposure period was too short to realistically detect impacts on longer-term outcomes but also highlighted that

medium-term outcomes related to investment (which would have been a positive indicator of future income gains) were not found. This evaluation would have benefited from clearer information about the expected timing and magnitude of long-term impacts; it is possible that longer-term outcomes could have been detected in later rounds of data collection.

El Salvador. The impact evaluation of improvements made to El Salvador's Northern Transnational Highway (NTH) was intended to assess impacts on a range of outcomes from access to markets and increased productive use of land to household income. It was found that the NTH modestly reduced travel time to households' nearest market as well as travel time to various services, and lowered the cost of accessing them. Yet, there were no significant changes in agricultural sales, harvests, land values, income, or expenditures. There were delays in the construction of the NTH that resulted in most segments being completed in later stages of the project; therefore, the evaluation captures short-term effects, since longer-term benefits may take longer to materialize. MCC is planning on conducting a second evaluation focused on benefits to road users and maintenance of the road that, among other things, will help MCC assess whether or not it is worth conducting additional rounds of household data collection to detect longer-term outcomes.

Georgia. The Georgia impact evaluation employed three quasi-experimental methodologies to evaluate various levels of outcomes resulting from rehabilitation of the Samtskhe-Javakheti Road. The evaluation confirmed that traffic volume and travel speeds along the road increased. Self-reported travel times also generally decreased. Interestingly, the evaluation found an increase in the number of industrial facilities in settlements near the upgraded roads; however, it was unable to assess whether these facilities were completely new or had moved from another location to be closer to the road. Price impacts were inconclusive, and no impacts were detected on incomes or the utilization of health and education services. Like in the case of Armenia, this evaluation may have been more informative if the endline had been conducted more than a year after construction was completed, or if an additional round of data had been collected. Timing and content of surveys could have been improved with more up-front detail on the timing and size of expected results.

Honduras. The Honduras evaluation, employing both quasi-experimental and road economic modeling approaches, confirmed that the investment reduced travel times and costs as expected. It also detected an impact on incomes, but the findings were not immediately intuitive, as agricultural incomes increased and non-agricultural incomes decreased. A detailed theory of change for the investment could have potentially clarified how the road investments were expected to influence incomes. Analysis of the primary, secondary, and tertiary roads indicated strong post-compact estimated ERRs,[18] barring a small number of outliers that fell below 10 percent. Overall, the evaluation

18 ERRs that are estimated by MCC's independent evaluators in the post-compact period are referred to as post-compact ERRs. These are generally based on data that is collected one year or more after completion of the road works.

was able to validate that the project produced the intended immediate effects, but did not provide evidence that generally positive impacts on growth would occur.

Nicaragua. The Nicaragua study employed a quasi-experimental impact evaluation methodology to assess the impacts of investments in three secondary roads. The impact evaluation aimed to answer the question of whether the rehabilitation of the roads affected the prices of consumer goods across the highly integrated Nicaraguan road network. It studied the consumer goods basket used to calculate the national cost of living index but was unable to find significant effects on prices across the basket. The results of a separate analysis indicated that the project was not likely to produce economic returns as high as anticipated, as post-compact ERRs were estimated to be below 5 percent. The lower than expected estimated ERRs were driven partly by capital costs that were significantly higher than estimated in the feasibility studies, underscoring the benefit of more complete feasibility work prior to an investment decision.

Vanuatu. The Vanuatu performance evaluation confirmed that traffic counts on both national roads had increased and vehicle operating costs had decreased, though post-compact estimated ERRs for the roads were not as strong as expected. Evaluation results indicated that road sections with average annual daily traffic counts of above 400 were most likely to produce significant economic benefits, while those with counts below 300 were not. This finding highlights the importance of first collecting accurate data to understand baseline levels of traffic, and then investigating assumptions about how traffic may grow over time early in the project development cycle. It also demonstrates that segment-specific analysis is important when considering a road investment and that paving an entire road may not be necessary if traffic differs by segment. Finally, it demonstrates that it is critical to incorporate sensitivity analysis into the CBA to understand what level of ERR risk MCC is taking on in its assumptions about key parameters like traffic counts.

Lessons from MCC's Approach to Road Investments

MCC's review of the agency's prior experience investing in roads yielded the following seven lessons.

1. Understand the specific problem that a road investment aims to resolve and let that problem articulation inform project development

MCC's road evaluations did not detect significant impacts on targeted outcomes related to agricultural production, tourism, incomes, or consumer prices. This null result raised two important questions: First, whether MCC had correctly understood the likely impacts of the selected road investments in their particular contexts; and second,

whether the evaluations had been designed appropriately to capture those impacts. The relevance of the evaluation design will be addressed below in lesson 7. However, investigation into the theories of change underlying early road investments revealed that there was little documented data or analysis to support the linkage between road improvements and expected long-term outcomes for many road projects. Expected outcomes included increased tourism, agricultural productivity, and private investment, as well as improvements in regional and international trade. For example, both the Georgia and Armenia roads projects aimed to improve performance of the agricultural sector, in part, through road improvements. In Georgia, agricultural investments were made in the same targeted region as the road works, but there was little known about how these two types of investments would interact or whether the benefits would be complementary. In Armenia, roads with the highest ERRs (driven mostly by current traffic) were selected without targeting agricultural zones. The exact pathways through which the roads might have impacted agriculture were not explicit in the project design, and impacts on agricultural outcomes were not detected.

With these evaluation findings, MCC better recognizes that the ability of a project to achieve and demonstrate its results requires a clear understanding of the problem being addressed by the investment and a theory of change that is supported by evidence. This may seem less germane to the development of infrastructure projects, where the focus is often on engineering decisions, but it is critical when infrastructure is the chosen vehicle by which to achieve economic growth and poverty reduction. A well-articulated theory of change should serve as the foundation for project design and guide teams throughout implementation.

Most MCC road investments have arisen from transport-specific constraints to growth, such as poor road quality or high transportation costs. In this first scenario, a problem analysis must explore the dynamics surrounding transportation costs in a particular country, the sectors that are most impacted, and how demand for transportation services might change. For example, are high transportation costs driven solely by poor road quality, or is the level of competition in the transportation market also a contributing factor? Are transportation costs a significant driver of the price of consumer goods such that we can expect consumer prices to fall if transport costs fall? Understanding these interactions is critical to selecting and designing the most appropriate road intervention for growth and poverty reduction and identifying the type and magnitude of outcomes that can be expected from that intervention. While economic benefits would come from reductions to vehicle operating costs and travel times (VOCTTS), a theory of change would need to explain how changes in traffic are expected to result. Grounding the expected benefits in an economic model of demand for transportation services is also important.

A second scenario for road investments occurs when a constraint outside of transport (often in agriculture) is proposed to be addressed, at least in part, by a road (as in the examples of Armenia and Georgia). In this situation, the theory of change should first consider the issues described above and then go beyond VOCTTS to explain

how reductions along those parameters would result in another set of outcomes. If the constraint states that agricultural production is limited by high transport costs on market roads, the targeted results of the project would relate to agriculture and necessitate a focus on agriculture as well as road engineering during project design. While the benefits modeled in the economic analysis of the road investment would still derive solely from VOCTTS, assumptions about traffic growth should link explicitly to changes in agricultural productivity in the vicinity of the upgraded road. It is important to look beyond road traffic alone to understand how markets that rely on the road will change. Experts in both transport and agriculture (or other sectors in question) must collaborate to ensure that both the engineering of the road and expected impacts on agriculture are fully understood prior to investing.

2. Prioritize and select projects based on a road network analysis

MCC calculates closeout ERRs shortly after a compact ends, and these estimates reflect final project costs, updated assumptions, and data on realized benefits, if available at the time. Of the 15 closeout ERRs estimated for MCC road investments, 9 were below 10 percent (see Appendix B for a summary of the ERRs). As previously discussed, many road projects faced cost pressures that caused their estimated ERRs to decrease, but the fact that more than half fell to a point below MCC's hurdle rate of 10 percent warranted consideration about whether MCC had selected the right road investments up front. MCC's model espouses both country ownership and a reliance on evidence and economic analysis to inform investment decisions, though these principles may not always align perfectly, particularly if partner countries identify priority roads for political reasons. In the past, MCC balanced these approaches by accepting partner country proposals as the universe from which to select road projects, and then using CBA to prioritize investments within that pool. However, this limited MCC's pool of investments and its ability to choose the highest-return road investments overall. Road projects in Nicaragua and Vanuatu, for example, resulted in relatively low-return investments because of the above-described selection pathway.

From an operational perspective, the roads MCC selected in early compacts were often difficult to construct in a five-year time frame and resulted in de-scoping. Road projects in Cabo Verde, Ghana, and Mozambique were de-scoped, in some cases to less than half of what was originally planned. The September 2012 Government Accountability Office audit of six MCC road infrastructure projects found that the kilometers to be paved in Armenia, Cabo Verde, Georgia, Honduras, Nicaragua, and Vanuatu compacts were reduced by a combined 63 percent.[19] This further fueled an internal discussion of whether MCC had selected projects that were realistically implementable within the parameters of its model and would produce the best value for taxpayers.

19 U.S. Government Accountability Office, Millennium Challenge Corporation: Results of Transportation Infrastructure Projects in Seven Countries, September 12, 2012, http://www.gao.gov/products/GAO-12-631. The study included the modernization of the Port of Cotonou in Benin, which did not include road works.

In response, MCC has learned that road investments should be identified in the context of the national road network or a targeted regional network. This is particularly important in cases where the constraint points broadly to the quality of roads or where multiple roads could be targeted for improvement. Road network analysis would allow MCC to:

- ★ Identify the highest-return projects through project prioritization across the network, highlighting where the best economic returns are and avoiding the 'worst road first' approach. The economic viability of a road depends largely on existing traffic counts, and while a proposal to pave a dirt road that would connect remote rural communities may be qualitatively appealing, putting the same amount of money toward maintenance on a set of roads with higher traffic counts will often produce much larger economic returns by impacting a higher number of beneficiaries.
- ★ Have an objective assessment of how projects are selected and funded, which is key to reducing opportunities for fraud, corruption, or other questionable practices.
- ★ Assess the ability and performance of the road agency to plan and manage its road asset inventory, which is critical to understanding and supporting the sustainability of road investments.

For MCC's road investments to produce the highest return for the largest number of beneficiaries, they must require an analysis of the relevant road network that assesses key criteria, such as current traffic volume and road roughness. This type of information, which would be verified by MCC in the field, would allow economists to estimate expected returns across a wide geographic area and enable MCC to prioritize investments that would be the most economically viable. This process of in-depth investigation before specific road investments have been identified would allow MCC to better understand the completion risk associated with potential roads and avoid those that might not be suited to MCC's model.

Network analysis is standard practice in countries with well-developed road networks and is an important component of a roads maintenance system. By standardizing this requirement for all compact proposals related to roads, MCC hopes to encourage and support the adoption of best practices for planning and maintenance by road authorities in partner countries.

3. Address policy and institutional issues in the transport sector up front to ensure sustainability of road investments

MCC recognizes the importance of ensuring that appropriate institutional and policy environments are in place to support the sustainability of road investments. A country's institutional practices in road maintenance and network analysis are critical areas for planning, executing, and evaluating cost-effective, sustainable investment. However, these areas have not been studied as closely by MCC as infrastructure-related issues

have. While the structural capacity of MCC roads was engineered to last approximately 20 years under a specific maintenance regime, the reality may be that assumptions about partners' maintenance practices might not hold, leading to a shorter road lifespan. In the experience of all donors, road failures can be caused by factors other than structural capacity, such as poor material quality, poor drainage, or overloading. However, a road agency with sound planning and maintenance systems in place should be able to prevent or mitigate these situations in a timely manner.

Though many MCC road projects incorporated maintenance-related interventions, these activities were generally small and lower priority than the construction work. Compacts usually addressed maintenance by incorporating a condition precedent that made project funding disbursements contingent on the partner country financing its road maintenance fund. However, these measures did not directly ensure that maintenance funds were used each year. MCC incorporated institutional strengthening activities for road planning and maintenance in four compacts. MCC directly invested in strengthening the road maintenance funding and oversight entity in Burkina Faso and helped to set up community-based contracts for routine maintenance along the two upgraded roads in Vanuatu. In Mongolia and Tanzania, however, maintenance work was overshadowed by challenges with completing road construction on time, and therefore, it was not fully implemented.

Timely and appropriate road maintenance procedures are critical to the sustainability of road investments and need to be a key area of focus during compact development going forward. Maintenance is less costly than rehabilitation or upgrading. With proper maintenance, a paved road can be built to last much longer than 20 years without the need for major structural work.[20] A system for regularly updating and analyzing conditions along the road network would enable a road authority to pinpoint key areas for investment and plan and execute its budget effectively. Other areas for policy and institutional interventions include improving the planning and management of transportation assets, which may involve, for example, developing a highway master plan, rationalizing annual programs with available budget, improving project/contract management processes, or improving maintenance contracting.

It is important to address the institutional environment, particularly related to maintenance, up front, and MCC is committed to doing so going forward as a precursor to capital expenditures. As MCC further structures its approach to policy and institutional reform, the agency will assess partner governments' needs, plan activities to achieve feasible and measureable institutional improvements, and evaluate those achievements. This will increasingly involve political economy analysis of relevant institutions during compact development to diagnose critical needs and design better interventions. MCC's engagement with partner countries should prioritize these issues so that partners are fully committed to implementing sound maintenance practices and allocating sufficient

20 Pavement Interactive, "Perpetual Pavements," *http://www.pavementinteractive.org/article/perpetual-pavements/*.

funding to support the sustainability of their existing road network before MCC commits to capital-intensive road investments.

4. Develop guidelines to promote consistent application of economic analysis tools across road projects

Cost-benefit analysis of road projects at MCC is conducted using one of two economic modeling tools, depending on the types of roads being analyzed. MCC economists use the HDM-4 to model highways and the RED model for rural roads. MCC economists conduct CBAs and estimate ERRs at three stages of project implementation: (1) ex-ante ERRs are calculated for all project proposals to inform MCC's investment decision; (2) re-scoping ERRs are calculated in cases where significant changes to the project costs, scope, or beneficiaries are contemplated; and (3) closeout ERRs are calculated upon completion of the project using updated costs and assumptions.[21] A summary of the ERRs calculated to-date is included in Appendix B. While the CBAs for MCC road projects generally followed existing roads models, the assumptions used to build each of the models were not always consistently derived and were based on data of varying quality. There have also been exceptions where no road CBA was completed at closeout and where HDM-4 was used for rural roads.

The previously noted peer review of HDM-4 analysis recommended improvements in the application of the model, including: expanding and improving data collection practices for HDM-4 inputs, clearly identifying modeling assumptions, improving documentation of models and creating templates for doing so, and capturing a larger set of benefit streams like reduced injuries/accidents and emissions reduction. Some of these recommendations were applied in the case of Liberia, where a maintenance analysis was conducted as part of the CBA and contributed to the team's decision to prioritize maintenance funding over road construction. A key implication of the MCC cost study is that CBAs should be based on the final design cost estimates, as early cost estimates based on pre-feasibility studies at times led to overly risky investment decisions. If full feasibility studies are not complete at the time of the investment decision, cost estimates should be increased in the model or a sensitivity analysis should determine a cutoff point at which a cost overrun makes the project unviable.

21 In some cases, additional post-compact ERRs that incorporate the findings of the evaluations have been calculated by the independent evaluator contracted by the Monitoring and Evaluation team. These are reported in the evaluation summaries in Appendix A.

In response to these findings, MCC is developing a standard set of guidelines for economic analysis of the transport sector. These guidelines will address the problems identified in the peer reviews by detailing the following:

- ★ What data is needed to conduct road CBAs
- ★ How data should be collected to meet the MCC CBA requirements
- ★ How traffic growth and shifts will be estimated for both major roads and road improvements targeting specific communities
- ★ How assumptions about maintenance over the project life will be derived from consultation with the local roads maintenance authority
- ★ How safety and environmental factors should be incorporated into the model

These guidelines will outline requirements for conducting closeout traffic counts, including the minimum post-construction exposure period, minimum number of days and hours of data collection, and methodologies for converting one set of traffic data into an estimate of average annual daily traffic. Because the results of road CBAs are so sensitive to assumptions of future traffic growth and future maintenance practices, the guidelines also provide guidance on how each CBA will incorporate multiple scenarios (e.g. optimal, minimal, and no maintenance) that demonstrate how the ERR will be impacted if maintenance or traffic growth differs from what is assumed in the core model. These scenarios will allow MCC to make investment decisions with a better understanding of what is uncertain in the expected returns and what outcomes are needed to make the investment worthwhile. They will also help MCC and its country partners understand the economic implications of improved maintenance practices. With these guidelines, MCC anticipates that CBAs of road projects will become more standardized in terms of methodology and reflect similar levels of rigor, data completeness, and data quality.

5. Require enhanced design review for road investments throughout the project lifecycle to better manage completion risk and improve investment value

Findings from MCC's roads portfolio review suggested that road investments could be improved by establishing and enforcing a rigorous standard for feasibility study content and quality prior to the investment decision. Frequent instances of completion risk — and associated re-scoping and cost increases — could have been prevented by earlier and more intensive reviews of costs and timelines prior to an investment decision. The MCC cost study recommended establishing and enforcing an MCC standard for design review that incorporates a greater level of technical expertise at all stages of the project cycle.[22] It also suggested that MCC consider alternative forms of engineering contracts

22 Chong and Hopkins (2016), p. 65.

to improve the quality of contractor work, as long-term, multi-year contracts spanning feasibility, design, and supervision are difficult to write and price, and often result in substantial cost escalations. The expectation is that by investing more in design review up front, MCC will reduce the risk of delays and cost overruns during construction.

Applying these lessons, MCC began implementing several project management and cost control measures during road construction in Burkina Faso and Senegal, which significantly reduced cost overruns. In Côte d'Ivoire, road project development has undergone constant design review, allowing the team to remain nimble in choosing where and how to invest to maximize benefits to the country. In addition, MCC is introducing a standard for design review across the compact lifecycle to help improve investment value, and since 2013, has adopted guidelines for road development and implementation. The guidelines are aimed at improving the consistency and quality of MCC's road investment practices while also ensuring greater cross-sector integration throughout the project cycle. They cover topics such as sustainability, cost effectiveness, transparency, quality assurance, reduction of fraud and corruption, and promotion of technology transfer.

The envisioned design review process will formalize how MCC collects and checks fundamental design input data to ensure the viability of assumptions going into the initial economic analysis. This will occur before starting engineering design. Jointly with a partner country, MCC will conduct a value engineering review during the design phase that uses CBA as a tool to determine the most cost-effective and highest-value design solution(s). Once an engineering design solution is selected, MCC will continue its oversight of the construction process through random verification of the design requirements (structural and functional) to not only ensure conformity to the design but also to identify further design optimization opportunities that would maximize economic benefits to the population. The final stage of the review process will be the validation by all stakeholders of the completed road, including performance-based testing of the functional and structural capacity of the road. This data will allow for a more informative closeout ERR.

Going forward, MCC will implement a more collaborative and technically driven design review, starting from the project development stage through closeout. First and foremost, MCC recognizes that failure to conduct a full feasibility study prior to a road investment decision increases completion risk. In addition, MCC expects this approach to result in road projects with better value by ensuring that design decisions are driven by both technical and economic data.

6. Standardize the content and quality of road data collection across road projects

In response to feedback from peer reviewers on the road CBAs and the analysis of cost overruns, MCC has recognized the need to take a more active role in securing

accurate and complete data to feed into the CBA and project budgeting. In the past, MCC has made investment decisions based on incomplete or unverified information, which resulted in design and implementation challenges. The peer reviewers noted that data collection approaches for common measures, such as traffic counts, travel times, and vehicle operating cost inputs were often poorly documented or unreliable. In the Senegal Compact, ERRs ended up being less robust than originally calculated due to poor quality data that had overestimated the roughness of existing roads, and thereby, overstated potential benefits.

MCC will, therefore, standardize the types of data collected for prospective and completed roads projects in such a way that meets the needs of project design and implementation, CBA, and monitoring and evaluation, allowing the agency to make better-informed investment decisions. To this end, MCC has developed guidelines for a standard package of data collection that includes traffic counts with fleet composition, origin-destination surveys, International Roughness Index sample measurements, and deflection sample measurements, at a minimum. MCC is also revising the standard set of indicators to be reported by road projects, to ensure that monitoring data is collected in a consistent manner across all road projects throughout the various stages of implementation. In particular, MCC is developing standardized approaches to documenting cost information through design and implementation phases, and tracking progress on both base and surface-level road construction. By standardizing technical specifications and deliverables for road data collection and key performance indicators, MCC expects to see improvements in data quality and analysis.

7. Better balance cost and the potential for learning when designing road project evaluations

MCC's independent evaluators have attempted a variety of rigorous evaluation approaches to road projects. While early road evaluations were able to detect immediate impacts on travel times, transportation costs, traffic counts, and access to markets and facilities, they were only able to detect intermediate or long-term impacts on prices, production, and incomes to varying degrees. MCC assessed these evaluations to understand the role that methodology played in measurement and found that the evaluations faced a number of challenges related to attribution, statistical power, and the timing of data collection. In other words, the evaluations' inability to show long-term outcomes may be a function of poor evaluation design, rather than or in addition to poor project design. These experiences have clarified some critical challenges in evaluating roads projects:

- ★ *Roads projects do not lend themselves easily to rigorous evaluation approaches.* Randomization is not often feasible, both because it is rare to have a large enough pool of potential roads from which to randomly assign treatments and controls, and because practical considerations may influence the selection of road segment. Quasi-experimental methodologies are more realistic, but the identification of a

valid counterfactual is not straightforward, as the improvement of a particular road segment potentially has broad road network effects.

- ★ *A road investment's impact on economic growth often relies on a variety of factors external to the road investment, making the theory of change complex and challenging to validate through an evaluation.* As noted previously, it is important to understand the various pathways through which a road improvement contributes to economic growth so that the evaluation can attempt to measure intermediate outcomes that precede harder-to-measure long-term outcomes, such as income or poverty.
- ★ *The size of potential impact complicates road evaluations and can make them more expensive*. It is difficult to estimate the magnitude of impact on high-level outcomes such as private investment, production, or income, and this presents challenges to ensuring that an evaluation has sufficient statistical power to detect impacts. It is likely that direct income impacts at the household or business level resulting from road improvements will be relatively small for most individual beneficiaries, even though the aggregate across the potential beneficiaries linked to the road network could be large. Capturing household or business impacts on income that would allow one to validate expected macro-level impacts of road investments would require very large samples and therefore be extremely costly.
- ★ *The timing of data collection is critical but not an exact science.* Given that the mechanisms through which a road may influence high-level outcomes are context-specific, there is no conventional wisdom on when to collect data after a road is completed. Transport experts agree that it is unrealistic to expect to see immediate impacts on high-level outcomes, and that a few years are required for those changes to manifest. They also advise collecting periodic traffic count data to assess whether traffic has increased enough to see changes in high-level outcomes, before timing final data collection. This is challenging from an evaluation planning perspective and limits the evaluation's ability to provide timely feedback on results. It also necessitates costly additional data collection in the period between construction completion and endline data collection.

Given the challenges around designing rigorous road evaluations, impact evaluations of road projects can be a risky investment. Particularly with respect to the issue of magnitude of impact, even an evaluation with a valid counterfactual and large sample size may not be able to produce useful learning. MCC made a deliberate attempt in its early road evaluations to direct independent evaluators to go beyond measuring the immediate outcomes of road quality improvements to capture impacts on higher-order outcomes. However, the returns from these high-cost evaluations were not substantial enough. With this background, MCC has revised its approach to evaluating road projects in favor of better balancing cost with the potential for learning.

Going forward, MCC plans to pursue impact evaluations of roads projects sparingly. They may be appropriate when there is evidence to support the idea that transport costs account for a large share of household or business expenditures and that the expected

impact on transport prices for the average road user will be large. In cases where a road project has been pursued to address a non-transport-specific problem or constraint, impact evaluations may still be developed to test whether the non-transport outcomes have been achieved (e.g. reduced agricultural import prices or increased tourism). Decisions to pursue an impact evaluation will rely heavily on a clear and evidence-based theory of change from the relevant sector(s) that specifies the magnitudes and timelines of expected impacts.

MCC's road evaluation approach has also shifted the focus of data collection. Previously, evaluations focused on measuring changes in outcomes for populations residing near the road; however, depending on the type of road, the main beneficiaries may not be those living close to it, but rather those accessing markets that the road now connects. MCC expects that focusing on road users — those traveling on the road, rather than surrounding populations — will produce more useful results that provide an indication of how the road is changing behavior. Furthermore, evaluations will focus more on better measuring immediate and intermediate outcomes such as road roughness, travel times, and transportation prices, rather than prioritizing higher-level outcomes. Lastly, every evaluation will now estimate a post-compact ERR using an accepted roads economic model, which will provide a more accurate reflection of returns to the road investment.

These changes are reflected in the following evaluation questions, which will form the core of future MCC road evaluations:

1. What is the economic return — calculated in terms of vehicle operating cost savings and travel time savings — of the road investment?

2. What are the relevant road authority's current maintenance practices and what is the likelihood that MCC's investment will remain adequately maintained? In cases where MCC investments target maintenance improvements, what are the effects of those efforts?

3. Have road usage patterns changed, in terms of who is traveling on the road, why they are travelling, what they are transporting, what they are paying for transport, and how long it takes to move along key routes?

4. How is the transportation market structured, and what is the likelihood that vehicle operating cost savings will be passed on to consumers of transportation services?

Future Learning in MCC's Roads Investments

MCC's past experience with road rehabilitation, upgrading, and maintenance has produced a wealth of learning within the agency that is already being applied to transport investments. Improved practices include:

- ★ Identifying and maintaining fidelity to the reason for investing in roads and the associated theory of change, as the project is designed, implemented, and evaluated.
- ★ Developing cross-agency standards on assumptions, benefits modeling, and data collection.
- ★ Consistently applying best practices, including network analysis, policy and institutional reform, and enhanced design and construction oversight during project design and implementation.
- ★ Focusing road evaluation questions to provide more timely and useful information.

In Senegal, enhanced design reviews revealed an opportunity to incorporate pavement recycling into construction, which resulted in cost savings and avoided environmental impacts. Network analysis has been incorporated into the development of the Nepal Compact, where the government has provided data on traffic and roughness across 2,000 km of the strategic road network to identify the highest return road segments for maintenance works. The road project in the Liberia Compact focuses entirely on the road maintenance regime, with potential for capital-intensive maintenance investments. Finally, 10 road evaluations have been restructured to align with the revised evaluation strategy.

Even with the significant learning and improvements that have been incorporated into MCC's practice, there remain areas for further exploration. MCC will pursue a learning agenda around the impact of transportation improvements on economic growth in the following areas:

1. Policy and institutional reform related to road maintenance

2. Methods for independent evaluation of road projects to estimate economic impact

3. Increasing use of available data and generating new data about road networks in partner countries

Policy and institutional reform

MCC is committed to addressing the policy environment and institutional capacities related to road planning and maintenance as part of all future road investments. However, bringing about institutional change is a complex challenge and no standard approach will apply to all situations. MCC is currently identifying a set of policies and procedures that should exist within road institutions in order to conduct road maintenance appropriately, and these may be used as criteria for assessing institutional readiness or development needs. The road maintenance program being developed for the recently signed compact with Nepal is expected to provide opportunities to test these approaches.

Independent evaluations

MCC is now pursing an evaluation approach that centers on modeling VOCTTS, assessing maintenance practices, and measuring changes in and benefits for road users. In future road evaluations, MCC will learn practical lessons about attracting the right combination of evaluation and engineering expertise to conduct comprehensive and cohesive road evaluations. In addition, evaluation results should provide context for the final ERR estimate and inform assumptions about maintenance and traffic growth in future economic analysis.

High coverage, high frequency data for transportation project analysis

MCC hopes to integrate high coverage, high frequency open sources of road data into its transportation work. Critical areas where more data is necessary include locations of transportation network infrastructure, infrastructure condition, connections, and road use. New data collection tools include road roughness apps, visual algorithms for video traffic counting, and crowd sourcing options such as OpenStreetMap data. MCC will be guided by the following research questions in its use of the data:

1. What data on transportation exists in MCC's partner countries? Is this data in a format that is useful to MCC?

2. How does data collected using MCC's standard data collection and analysis method (e.g. for traffic counts) compare to data collected via open data sets or new data technologies, such as traffic cameras or crowdsourcing?

3. How has MCC's use of open road data changed compact development, implementation, or evaluation?

4. How is MCC using its own internal data and integrating it with open or external data? Has data integration helped learning or changed practices?

MCC's future road investments will be improved by consistent use of economic and engineering models in independent evaluations, by targeted exploration of new economic effects of transport system investments, and by leveraging open data to better understand road networks. Publication of learning and the data on which it is based will aim to inform the wider transportation and development communities. With its large number of road projects across several countries, MCC has an important opportunity to share knowledge about the design and impact of road improvements in low-income countries. By implementing the set of lessons discussed in this paper and pursuing the roads research agenda, MCC expects future road investments to produce higher returns for beneficiaries and to be maintained through a well-developed planning and maintenance system implemented by partner countries.

Appendix A: Evaluation Results

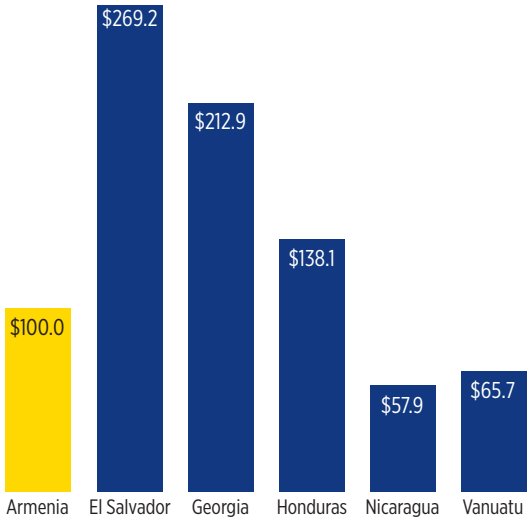
Armenia Rural Road Rehabilitation Project

Summary

MCC constructed approximately 24km of pilot roads using $8.4 million before a hold was placed on funding for the Rural Road Rehabilitation Project in March 2008. Subsequently, the Armenian government began accessing loans from the World Bank to rehabilitate many road sections that were included originally in the RRRP plans. Between 2009 and 2013, the World Bank financed $100 million of road rehabilitation for 430km under the Lifeline Road Improvement Project primarily based on the MCC road designs. These roads were part of the Armenian government's proposed lifeline road network, which was intended to provide rural communities with road access to markets, social services, and the main road/interstate network.

Expected Results

1. Decreased VOCs
2. Increased traffic
3. Improved access to agricultural markets and social infrastructure
4. Increased agricultural investment, employment, and production
5. Temporary employment related to road construction



ERR at Investment Decision

25.50%

Monitoring Results

On the World Bank loan-funded roads: The kilometer target of 430km was exceeded, with 446km ultimately rehabilitated. The job creation, transport cost reduction, and travel time reduction targets were also exceeded.

Independent Evaluation by Mathematica Policy Research

Evaluation Type

Impact Evaluation

Difference-in-differences with matching. The evaluation compares 27 road sections that were originally designed by the MCC Armenia program and then financed by the World Bank with 28 road sections that were originally included in the MCC Armenia program, but not rehabilitated.

Exposure Period

- Baseline data collected in 2007 and 2008
- Road upgrades mostly completed in 2009-2010
- Endline data collected in 2011
- Exposure period of 12-24 months

Evaluation Questions

1. Did rehabilitating roads affect the quality of roads?
2. Did rehabilitating roads improve access to markets and social services?
3. Did rehabilitating roads improve income from employment?
4. Did rehabilitating roads affect agricultural productivity and profits, and if so, by how much?
5. Did rehabilitating roads improve household well-being for communities served by these roads, especially income and poverty?

Findings

Immediate

1. 39 percentage point improvement in favorability rating of regional roads
2. Strong indirect evidence of large reductions in travel times and vehicle operating costs (increased approval for transportation services, increased use of roads for non-commercial purposes, and decrease in time spent using roads to sell agricultural production).
3. Inconclusive findings of impact on temporary employment linked to construction, despite project output of employing construction workers.
4. 20% decrease in perception of market access difficulties

Short-term:

5. No evidence of impacts on access to social services
6. 17 percentage point increase in use of roads for non-commercial purposes
7. Some evidence of impact on increased commercial activity on roads through increase in use of roads to buy agricultural inputs and decrease in days roads were used to sell agricultural production.

Medium-term:

8. Limited evidence of small impacts on investment (only small effect on livestock purchase)
9. No evidence of impacts on employment
10. Limited evidence of impact on production (increased jam and preserved vegetable production, decreased egg sales), but may be anomalous
11. No evidence of impacts on transactions

Long-term:

12. No evidence of impact on household income or household consumption.
13. Some evidence of increase in rural poverty, but likely an anomaly due to sample composition

El Salvador Connectivity Project

Summary

Constructed, improved, or rehabilitated 223.3 km of the Northern Transnational Highway, to reduce transportation costs within the Northern Zone, to the rest of the country, and to neighboring countries.

Expected Results

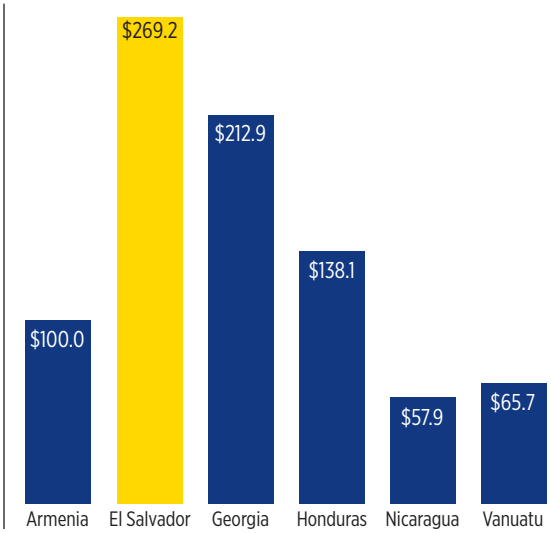
1. Improved road quality
2. Increased traffic
3. Reduced transportation costs
4. Increased access to markets and public services
5. Increased productivity and income diversification

ERR at Investment Decision

23.90%

Monitoring Results

Revised kilometer target was surpassed.



Independent Evaluation by Social Impact with the International Food Policy Research Institute

Evaluation Type

Impact Evaluation

Three empirical strategies to identify the effects of a transport artery within the Northern Zone on the outcomes of interest:

1. Regression Discontinuity
2. Continuous Treatment
3. Dynamic Regional Computable General Equilibrium.

Exposure Period

- Baseline data collection: 2009
- Program implementation: May 2009 to Nov 2012 with different segments being completed at different times
- Interim data collection: 2010, 2011, 2012
- Final data collection: 2013
- Exposure period after final data collection of 12 to 24 months.

Evaluation Questions

Does access to the improved NTH:

1. Increase access to markets in the northern zone?
2. Increase the use of health and education services?
3. Reduce agricultural transportation cost?
4. Improve market participation by increasing the likelihood of going to the market and/or the volume sold in the market?
5. Increase income from agricultural sources?
6. Increase the availability of non-farm employment?
7. Promote the creation of non-farm enterprises?
8. Increase income from non-farm sources?
9. Affect the time allocation across labor and leisure activities?
10. Change the labor allocation between farm and non-farm activities?
11. Increase land investments and land values in the northern zone?
12. Do effects differ for men and women or across socio-economic groups? What factors might explain this?
13. What is the impact of the NTH in the entire economy of the northern zone of El Salvador? And across other regions of the country?

Findings

Using regression discontinuity and continuous treatment:

1. Reduced travel time to a household's nearest market by 3 to 18 minutes.
2. Modest reductions in self-reported travel time to various services and lower costs of accessing those services.
3. No impact found on land ownership or land values.
4. No impact found on the probability of cultivating cash crops nor the probability of selling agricultural production.
5. A significant increase in overall self-consumption of agricultural output was found (though this impact varies significantly across regression discontinuity comparison groups and specifications).
6. Results were seen in patterns of agricultural input use. For example, fertilizer use increased.
7. For women, there were increases in non-agricultural hours of work and decreases in agricultural hours of work. There was some evidence that increases in time allocated to non- agricultural activities were driven by reductions of leisure time and less so from reallocation from agricultural work. This impact is not robust to all of the specifications and is restricted to some of the regression discontinuity groups (i.e. this effect only took place in groups that had longer exposure to the highway).

Using computable general equilibrium model:

The simulations found that an increase in productivity in the agricultural sector in the Northern region of the country has a much larger impact on the Gross Domestic Product (GDP) growth rate than an investment strategy of improving the transportation network. The GDP growth rate rises slightly, but the rate of growth of household consumption actually falls. The additional growth in production does not offset the increase in investment necessary to produce it, given that the investment is financed domestically. The improvement on the NTH reduces the transportation costs by ten percent for all agricultural commodities produced in the north region. Reducing transport costs without an increase in productivity associated with it does not appear to have a very big payoff.

Georgia Samtskhe-Javakheti Road Rehabilitation Activity

Summary

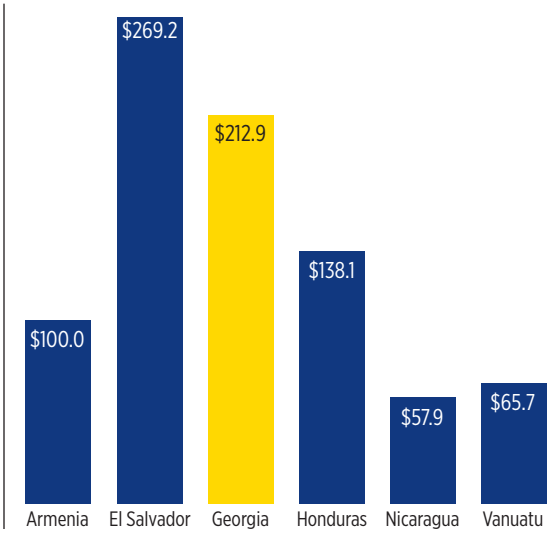
Rehabilitated key portions of dilapidated infrastructure along the Samthskhe-Javakheti (SJ) road (220km), which connects the S-J and Kvemo-Kartli regions with the capital city of Tbilisi and provides connectivity to Turkey and Armenia.

Expected Results

1. Decreased VOCs
2. Decreased travel times
3. Increased social, political, and economic integration
4. Improved transport for regional trade and accessing social services
5. Increased household consumption.
6. Increased business investment, primarily in agriculture

ERR at Investment Decision

20.00%



Monitoring Results

1. Kilometer targets were met
2. Travel time decrease target was slightly exceeded
3. Road roughness target was exceeded
4. Annual average daily traffic count target was not met, 85% achieved
5. Target for savings in VOC exceeded

Independent Evaluation by National Opinion Research Center

Evaluation Type

Impact Evaluation

1. Difference in Differences
2. Continuous Treatment
3. Difference in Differences with Propensity Score Matching

Exposure Period

- Baseline data collected in Spring 2008
- Road upgrades mostly completed by December 2010
- Endline data collected in May 2012 (traffic volumes), August 2012 (community), and Q4 2011 (household)

Evaluation Questions

The evaluation was designed to answer the following top-level question about the activity: "How does the road rehabilitation effect/cause economic development, new businesses, and economic and social integration in the region?"

In addition, the following categories of outcomes were explored by the evaluation:

1. Transportation related outcomes: traffic counts, vehicle speeds, travel times, and availability of public transport
2. Investment, land use, and employment: industrial investment, land uses, cropping patterns, employment
3. Market prices: the prices of basic commodities on the local market
4. Household welfare: income, consumption, asset ownership
5. Access to health and education: utilization of health care and education services

Findings

Traffic outcomes:

1. The volume of vehicles on project roads increased by an average of 44.2 vehicles per day (4.2%) with respect to comparison roads
2. The average speed along the roads increased by 13.6 km/h (24.4%) with respect to comparison roads.

Community-level outcomes:

3. Self-reported travel times to Tbilisi and to local markets were reduced significantly.
4. Strong evidence that S-J road improvement led to a 13.4% increase in the number of industrial facilities (i.e. canneries, factories, agricultural processing facilities, and similar enterprises) in settlements near the project roads.
5. Local prices were affected in complex ways (some increased, some decreased), whose interpretation is unclear.

Household-level outcomes:

6. No impacts were detectable on income, consumption, asset ownership, or utilization of health and education services at the household level.

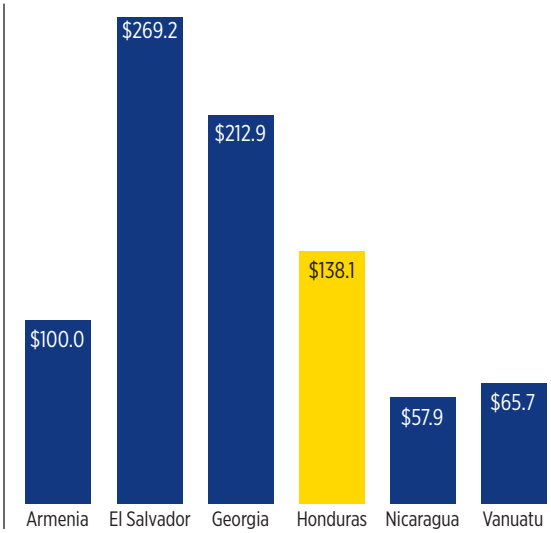
Honduras Transport Project and Farm to Markets Roads Activity

Summary

1. Rehabilitated two major sections (49.5km) of Highway CA-5, running north from Tegucigalpa to San Pedro Sula and the port of Puerto Cortes
2. Paved 65km of secondary roads
3. Upgraded 495km of rural roads

Expected Results

1. Decreased VOCs
2. Decreased travel times
3. Improved access to job market
4. Decreased price of consumables
5. Improved access to health centers and schools



ERR at Investment Decision

24.10%

Monitoring Results

1. 45% of the original CA-5 km target was met, 100% of the secondary road and 99% of the rural roads targets were met
2. Road roughness targets were not met for the primary and secondary roads: 84% and 31% for CA-5 segments and 72% for secondary roads.

Independent Evaluation by National Opinion Research Center

Evaluation Type

Impact Evaluation

1. Model-based approach using matching with continuous treatment effect (continuous treatment based on incremental changes in travel time or costs)
2. HDM-4 Model

Exposure Period

- Baseline data collected in August 2008 and traffic counts collected in 2009, 2010, and 2011.
- Most roads were completed in 2009-10.
- Endline data collected in March 2011.
- Exposure period of 3-27 months

Evaluation Questions

The evaluation of the Transport Project and Farm to Market Roads Activity aimed to answer whether or not improved conditions throughout the road network:

1. Lowered transport costs and travel time for businesses, including farm households;
2. Provided better access to a wider range of job opportunities for individuals (labor market effects);
3. Lowered the price of consumables and inputs by increasing competition and reducing barriers to entry posed by poor transport infrastructure; and
4. Improved access to health centers and schools

The overall expected result of these changes was an increase in overall incomes and employment at the household level.

Findings

1. The program intervention had a statistically significant effect of the expected sign on travel times and costs. For example, the cost of travel to hospital decreased by approximately $0.17 and the cost to health centers by $0.01.
2. Based on continuous treatment variables related to travel times and costs, the program intervention had a statistically significant effect on incomes for a randomly selected household in the country: monthly agricultural income increased by $3.50 and monthly non-agricultural income decreased by $5.
3. HDM-4 analysis estimated the following post-construction ERRs:
   - CA-5 Highway: Range of 12.1-21.3% for all sections except one, which was 7.6%. ERRs likely decreased from initial estimates due to final costs that were higher than 2008 estimates, higher road maintenance costs, and lower-than-expected traffic counts.
   - Secondary Roads: High increases in traffic counts and lower final project costs (relative to primary road work), resulted in high ERRs ranging from 29.4% to 188.3%.
   - Rural Roads: ERRs ranged from -9.8% to 298%, however the evaluators noted that the HDM-4 rural road ERR estimates are very sensitive to assumptions about future traffic growth and vehicle speeds and therefore tend to correlate closely with traffic volumetric flows. They also note that rural roads works costs are relatively low, and lower costs drive the higher rates of return.

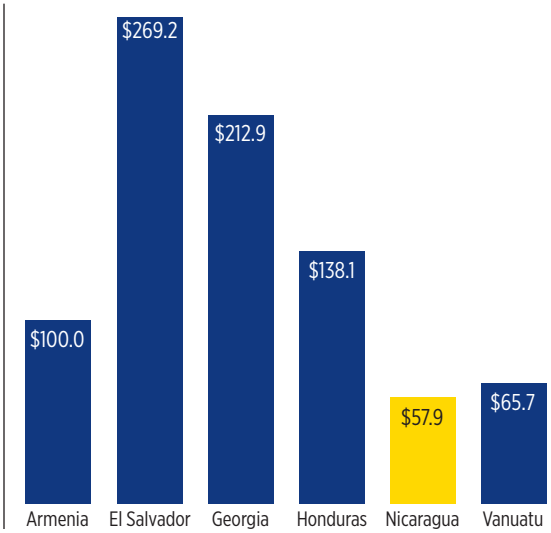
Nicaragua Transportation Project

Summary

1. Upgraded Somotillo-Cinco Pinos secondary road in the northwest of the country, covering flat and mountainous terrain (29.4km)
2. Upgraded León-Poneloya-Las Peñitas secondary road in the northwest of the country, connecting the urban center of León with coastal villages (19.6km)
3. Upgraded Villanueva-Guasaule secondary trunk road in the northwest of the country, connecting Villanueva with Honduran border (18km)

Expected Results

1. Decreased travel times
2. Decreased VOCs
3. Increased traffic
4. Increased availability of consumer goods
5. Lower cost of consumer goods



ERR at Investment Decision

13.20%

Monitoring Results

1. Kilometer targets were met for all roads
2. Road roughness targets were exceeded for two roads and met by 96% for the third road
3. Annual average daily traffic count targets were exceeded for all roads

Independent Evaluation by Jonathan E. Alevy, Ph.D.

Evaluation Type

Impact Evaluation

1. Ex-post ERR using RED model adapted for ex-post analysis
2. Difference-in-differences with matching analysis on availability and cost of consumer goods, comparing retail establishments in matched communities inside and outside the roads' zone of influence at baseline and endline

Exposure Period

- Baseline data collected in August 2008
- Road upgrades completed in early 2010
- Endline data collected in October 2010
- Exposure period of less than 12 months

Evaluation Questions

1. Did the rehabilitation of roads affect the quality of roads?
2. Did the rehabilitation of roads reduce vehicle operating costs?
3. Did the rehabilitation of roads affect the price of goods?
4. Did the rehabilitation of roads affect the availability of goods?

Findings

1. The ex-post ERR was calculated using the Roads Economic Decision (RED) model, which is applicable to rural roads. Inputs to the analysis confirmed that average annual daily traffic increased in the range of 12 to 44% on all three roads and that travel times decreased. Analysis of the International Roughness Index (IRI) data provided by the contractors modeled VOC decreases based on 2011 market prices for vehicle operations and maintenance materials. The study estimated that the ERRs had decreased to an average of 2.1%. This was in part due to increased capital costs that were 2.2% higher than estimated in the feasibility studies. These low ERRs may also reflect incomplete adaptations to the opportunities associated with the road rehabilitation, as endline data was collected less than one year after construction, where as benefits from infrastructure may emerge over two to five years post-project completion.
   - Somotillo-Cinco Pinos: -3.9%
   - León-Poneloya-Las Peñitas: 4.5%
   - Villanueva — Guasaule: 3.8%
2. The impact analysis studied the cost and availability of 53 consumer goods included in the basket of goods used to construct Nicaragua's cost of living index. The impact of the roads on the value of the basic basket of goods is close to zero in both urban and rural areas. 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.

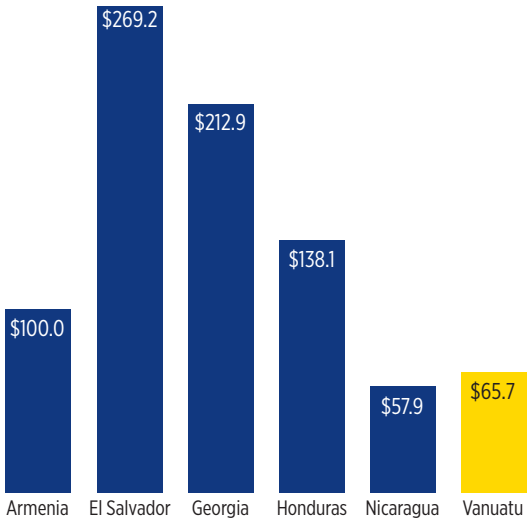
Vanuatu Infrastructure Transport Project - Roads Rehabilitation Activity

Summary

1. Construction and tar sealing of two of the most important national roads:
   - Efate Ring Road (92.5km)
   - Santo East Coast Road (57.2km)
2. Policy reform, technical assistance, and training of the Public Works Department for more effectively delivering maintenance/repair services and improved contract and roads management.

Expected Results

1. Increased tourism
2. Increased business development
3. Increased agricultural production
4. Improved road sustainability



ERR at Investment Decision

24.20%

Monitoring Results

1. Kilometer targets were met for both roads
2. Road roughness targets were exceeded for both roads
3. Annual average daily traffic count targets were exceeded for both roads
4. PWD staff training targets were exceeded
5. The number of days per year that the Efate Ring Road was impassable dropped from nine in 2006 to 1.75 in 2010 and zero in 2011.
6. VOCs reductions between 2011 and 2012 were projected to be $6,038,497

Independent Evaluation by Transport Research Laboratory

Evaluation Type

Performance Evaluation
HDM-4 Model

Exposure Period

The roads were formally completed in November 2010 and the HDM-4 analysis was conducted in March 2011. The exposure period is approximately 12 months as the road surface construction was completed prior to formal completion.

Evaluation Questions

Highway Development and Management (HDM-4) model analyses are used here to examine:

1. The economic viability of upgrading the roads and
2. The future performance and maintenance requirements of the roads

Findings

The ex-post ERR was calculated using the Highway Development and Management (HDM-4) model. Inputs to the analysis confirmed that average annual daily traffic increased approximately 191% on average on the Efate Ring Road and 59% on average on the Santo East Coast Road. Pre- and post-IRI data was not available, but was estimated to have reduced from 15 to 3. VOC reductions were modeled based on prevailing market prices for expenses such as: new vehicle, replacement tires, fuel, and lubricating oil. Reductions in travel time were not verified or incorporated into the analysis. The combined ERR for both roads was estimated at 10.3%, with 7.4% for Efate and 14.4% for Santo East. The ERR analysis by road segment indicated that roads with AADT above 400 vehicles were economically viable, while those with AADT below 300 were not.

Appendix B: Economic rates of return for MCC roads investments, along with details of funding obligations and completed road rehabilitation length[23]

Compact Details		Project Details			Economic Rate of Return			
Country		Project/ Intervention	Total Completed Length (km)	Roads Disbursements (Millions U.S. $)	Original	Revised	Closeout	Post-Compact
2005-2010	Cabo Verde	Roads and Bridges	40.6	27.70	13.6%		N/A	Pending
	Honduras	Transportation	610	118.06	24.1%		N/A	13.0%
2006-2011	Armenia	Armenia Rural Roads	24.40	8.44	25.9%		17.6%	N/A
	Georgia	Roads	220.2	212.87	20.4%	16.4%	15.5%	N/A
	Nicaragua	Transportation	67	57.88	13.2%		2.1%	6.3%
	Vanuatu	Transportation Infrastructure	149.7	58.33	24.2%		N/A	10.30%

23 This table reflects available data as of May 17, 2017 for closed compacts. Closeout ERRs were not calculated for some road investments for varying reasons. Going forward, post-compact ERRs will be calculated by the independent evaluator for all road investments.

Compact Details		Project Details			Economic Rate of Return			
Country		Project/ Intervention	Total Completed Length (km)	Roads Disbursements (Millions U.S. $)	Original	Revised	Closeout	Post-Compact
2007-2012	El Salvador	Connectivity	223.32	270.05	23.9%		21.6%	Pending
		Community Infrastructure (rural roads and bridges)			10.4%		11.3%	Pending
	Ghana	Trunk Roads	446.78	213.08	17.0%		0.0%	Pending
		Feeder Roads			18.1%		20.0%	Pending
		N1 Highway			36.0%	21.4%	33.0%	Pending
	Mali	Alatona Irrigation Roads	81	44.77	15.3%		N/A	Pending
2008-2013	Mongolia	Choir-Sainshand Road	176.4	66.49	17.0%		9.4%	Pending
	Mozambique	Rehabilitation/ Construction of Roads Project	253	133.81	10.3%		7.3%	Pending
	Tanzania	Mainland Trunk Roads	180	391.54	17.4%		N/A	Pending
		Zanzibar Rural Roads			11.6%		N/A	Pending
2009-2014	Burkina Faso	Banfora-Sindou	419	159.83	1.0%		-1.0%	Pending
		Sabou-Koudougou-Perkoa-Didyr			-0.9%		1.7%	Pending
		Dedougou-Nouna-Bomboroky-Mali Border			-0.4%		4%	Pending

Compact Details		Project Details			Economic Rate of Return			
Country		Project/ Intervention	Total Completed Length (km)	Roads Disbursements (Millions U.S. $)	Original	Revised	Closeout	Post-Compact
2010-2015	Moldova	Road Rehabilitation	96	109.75	21.1%		Pending	Pending
2010-2015	Senegal	National Road #2	372	238.51	10.9%	3 to 7%	7.9%	Pending
2010-2015	Senegal	National Road #6			11.3%	-6 to 2%	0.1%	Pending
2011-2016	Philippines	Secondary National Roads Development Program	222	138.12	13.7%		Pending	Pending