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Burgess, RSL, (2011) Infrastructure and Development: Evidence from India and East Africa
End of Award Report, RES-167-25-0214. Swindon: ESRC

ECONOMIC AND SOCIAL RESEARCH COUNCIL END OF AWARD REPORT



For awards ending on or after 1 November 2009

This End of Award Report should be completed and submitted using the **grant reference** as the email subject, to **reportsofficer@esrc.ac.uk** on or before the due date.

The final instalment of the grant will not be paid until an End of Award Report is completed in full and accepted by ESRC.

Grant holders whose End of Award Report is overdue or incomplete will not be eligible for further ESRC funding until the Report is accepted. ESRC reserves the right to recover a sum of the expenditure incurred on the grant if the End of Award Report is overdue. (Please see Section 5 of the ESRC Research Funding Guide for details.)

Please refer to the Guidance notes when completing this End of Award Report.

Grant Reference	RES-167-25-0214		
Grant Title	Infrastructure and Development: Evidence from India and East Africa		
Grant Start Date	1.1.07	Total Amount Expended:	£241,801.81
Grant End Date	30.6.10		
Grant holding Institution	London School of Economics		
Grant Holder	Professor Robin Burgess		
Grant Holder's Contact Details	Address	Email	
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Co-Investigators (as per project application):		Institution	

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1. NON-TECHNICAL SUMMARY

Please provide below a project summary written in non-technical language. The summary may be used by ESRC to publicise your work and should explain the aims and findings of the project. *[Max 250 words]*

Research in this project focuses on India and Kenya. In India we find that railway expansion during the colonial period dramatically reduced rural poverty by facilitating in-country trade and by mitigating the impact of weather shocks. Railway expansion was also associated with a significant reduction in excess mortality and famines caused by these shocks. In the post-Independence period we still find a strong link between hotter and drier weather and higher mortality in rural (not urban) areas, as well as evidence that reductions in agricultural production and wages and increases in prices link these outcomes. This suggests that effects of climate (change) will be unevenly distributed, motivating the need to find and fund investments that will mitigate the impact of adverse weather in rural areas. In Kenya we discover that ethnic favoritism in the provision of public goods may be a key factor underpinning underdevelopment in Africa. Using digitized road maps and public expenditure data across one hundred years we find that districts in Kenya that share the ethnicity of the president receive road investments two to three times greater than that predicted by the district's share in total population. Such favoritism becomes apparent soon after the transition from colonial rule to (single party) democracy, and periodically evaporates when a president from a different ethnic group enters power. The overall role of ethnicity attenuates after the transition to multi-party democracy in the early 1990s, suggesting that multi-party democracy may help African governments be accountable to their citizens in infrastructure provision.

2. PROJECT OVERVIEW

a) Objectives

Please state the aims and objectives of your project as outlined in your proposal to the ESRC. *[Max 200 words]*

- Provide a new data source that enables us to track development in Indian districts from 1870-2000
- Improve our understanding of how railway and bank branch expansion in India affected the pattern of economic growth and poverty reduction over the period
- Provide advice to the policy community on how infrastructure investment affects development outcomes in India via long-term development and mitigation of shocks
- Test the validity of existing theories of trade by using railway expansion in the British period as an experiment in reducing transport costs
- Understand the role that railways played in reducing the incidence of famines and starvation-related deaths in India
- To better understand the mechanisms via which bank branch expansion in the post-Independence period reduced rural poverty
- Create a new district panel data set for East African countries from 1950-2000 covering roads, politics and development outcomes
- Analyze whether African leaders favored districts from which they originated or shared their ethnicity
- Examine political biases in road placement in Africa as a possible cause of uneven patterns of development within East African countries
- Better understand the precise development benefits of districts obtaining larger investments in roads
- Provide recommendations to the policy community on how infrastructure provision can be used to promote development in Sub-Saharan Africa

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b) Project Changes

Please describe any changes made to the original aims and objectives, and confirm that these were agreed with the ESRC. Please also detail any changes to the grant holder's institutional affiliation, project staffing or funding. *[Max 200 words]*

The project allocated a portion of the travel budget to finance the hiring of additional Research Assistants. This was needed in order to complete extensive and complex data collection tasks in the UK, India and Kenya. This budget change helped to foster research skills and capacity of three PhD students who are supervised by the grant holder. ESRC has also condoned the purchase of a desktop instead of one laptop. Within the topic of infrastructure in India, our emphasis has been mainly on transportation infrastructure (and particularly railways), although the role of banks in avoiding excess mortality and reducing poverty through shock mitigation is also addressed. Finally, within the East African section of the project, we have focused on Kenya as this proved to be the most promising country in which to look at ethnic favoritism and also the place where we were able to find data on road-building, politics and development outcomes in colonial and post-colonial periods.

c) Methodology

Please describe the methodology that you employed in the project. Please also note any ethical issues that arose during the course of the work, the effects of this and any action taken. *[Max. 500 words]*

The methodology we employ is econometric analysis of district panel data for India and Kenya over a long time period, which can be divided into three research streams (references are made to outputs in the Findings section).

The first stream (see outputs (1-3) below) utilizes a dataset tracking the evolution of infrastructure, economic and health variables in hundreds of Indian districts annually from 1870 to 1930, constructed by digitizing data contained in official government publications from modern Indian ministries and states and from British Indian ministries and provinces. Once this dataset was organized and homogenized we used multivariate regression analysis to compare the evolution of outcome variables in each district before and after the district had access to transportation infrastructure. This method is only valid if the allocation of infrastructure to districts was 'exogenous' (independent of un-modeled innovations in the districts' outcome variables). To this end, we critically assess the plausibility of this assumption and to using methodologies (such as the related tools of 'instrumental variable' analysis) that overcome this endogeneity problem, thus enhancing our understanding of the plausibility of a causal effect of infrastructure provision on the studied outcomes.

The second research stream (see output (4) below) utilizes data for Indian districts for the period 1957 to 2000, which required the collection of detailed daily precipitation (Indian Meteorological Department), daily temperature (National Center for Atmospheric Research), and district mortality rates (as registered in the Vital Statistics of India, 1956-2000), as well as agricultural and economic outcomes. The weather data grid points were mapped to districts by inverse-distance weighting. We use semi-parametric methods to visualize the relationship between weather and mortality, as well as traditional parametric methods to estimate the causal effects of weather on mortality and economic outcomes. A range of econometric methods were employed to examine how district level infrastructure variables (e.g. banks) interact with weather in determining levels of mortality.

The third research stream (see output (5) below), on East Africa, employed extensive data collection procedures. We used Colonial Reports (Public Works Department, Road Authority, Blue Books), post-independence road maps (Michelin & Kenya Road Board), post-colonial Censuses and Statistical Abstracts, and Kenya Development Estimates to obtain the following data for Kenya: road development expenditure annually from 1901 to 2008; road building GIS data from 1897 to 2007; ethnicity and district of birth data for cabinet members post-independence, 1963-2007; demographic and economic

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data from the post-colonial Censuses and Statistical Abstracts; and additional colonial data on African reserves and White settlement. Econometric analysis was used to study the spatial impact of increased political representation on road investments in terms of expenditure and road building, with a focus on the ethnicity of the president and on the ethnicity of the second most represented group in the cabinet, showing that those results are not explained by district characteristics.

No ethical issues arose in the course of this work.

d) Project Findings

Please summarise the findings of the project, referring where appropriate to outputs recorded on *ESRC Society Today*. Any future research plans should also be identified. [Max 500 words]

Outputs on *ESRC Society Today*:

- (1) “Can Openness Mitigate the Effects of Weather Shocks? Evidence from India’s Famine Era”, Dave Donaldson and Robin Burgess, published in *American Economic Review: Papers and Proceedings* 10, May 2010, pp. 449–453.
- (2) “Can Trade Openness Reduce Real Income Volatility? Evidence from Colonial India’s Famine Era”, Dave Donaldson and Robin Burgess
- (3) “Railroads of the Raj: Estimating the Impact of Transportation Infrastructure”, Dave Donaldson, revise and resubmit *American Economic Review*
- (4) “Weather and Death in India”, Robin Burgess, Olivier Deschênes, Dave Donaldson and Michael Greenstone
- (5) “Ethnicity Meets Politics: One Hundred Years of Road Building in Kenya”, Robin Burgess, Remi Jedwab, Edward Miguel and Ameet Morjaria
- (6) “Cutting Trees to Harvest Votes: Micro-Evidence from Kenya”, Ameet Morjaria
- (7) “African Cities and the Structural Transformation: Evidence from Ghana and Ivory Coast”, Remi Jedwab

Using district-level data from colonial India (1870-1930), we estimate that railroads increased real agricultural income by approximately 18% in the average Indian district (output (3)). This is consistent with the welfare rise expected in a modern general equilibrium trade framework, given the corresponding reduction in trade costs reduction and expansion of trade volumes. We also estimate that by significantly expanding trade, India's railroads virtually eliminated the effect of local rainfall fluctuations on agricultural incomes and retail prices, mitigating the impact on rural living standards (outputs (1) & (2)). Railroads dramatically reduced the incidence of famines in colonial India and the death rate increase due to rainfall shortages.

With data from modern India (1957-2000), we document a large positive correlation between high temperature days and low rainfall days and district death rates (output (4)), which exists for rural adults and infants but not for urban populations, and is stronger in the growing season, suggesting that agricultural incomes’ weather-dependency links high temperature and mortality. Rural incomes (productivity, nominal wages, and prices) also respond strongly to high temperatures, while urban counterparts do not. Using climate change models, we show that predicted warming in India will result in significant excess mortality in rural areas but not in urban areas. In further work, we examine how financial and transportation infrastructure mitigate this impact of weather shocks on mortality.

In Kenya we discover that ethnic favoritism in public goods provision may underpin underdevelopment. Using digitized road maps and public expenditure data (100 years) we find that Kenyan districts sharing the ethnicity of the president receive road investments 2-3 times greater than predicted by the district’s share in total population (output (5)), which evaporates when a president of different ethnicity enters power. Favoritism becomes apparent after transition from colonial rule to (single party) democracy and attenuates after transition to multi-party democracy in the early 1990s, suggesting that multi-party democracy may help African governments be accountable to their citizens.

Two of our PhD students’ projects (output (6) & (7)) also generate new understanding of African

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development paths, linking Kenyan democracy with deforestation trends, and demonstrating the large effect of cash crop exports on African urban growth and infrastructure investment.

e) Contributions to wider ESRC initiatives (eg Research Programmes or Networks)

If your project was part of a wider ESRC initiative, please describe your contributions to the initiative's objectives and activities and note any effect on your project resulting from participation. *[Max. 200 words]*

The project has substantially contributed to ESRC-DfID Joint Scheme for Research on International Development (Poverty Alleviation), whose purpose is to "provide a more robust conceptual and empirical basis for development, and the achievement of the Millennium Development Goals (MDGs)." The project provides knowledge that is central to achieving MDGs on poverty and hunger, as well as to improving health and promoting environmental sustainability, which are central to the objectives of the ESRC-DfID Joint Scheme for Research on International Development (Poverty Alleviation). The project has helped to reinvigorate the study of infrastructure and its impacts on development outcomes. Following the inception of the project the study of infrastructure has formed a central part of the DFID Funded Research Consortium for Improving Institutions for Pro-Poor Growth (iiG) and there is now also an Infrastructure Research Program in the DFID funded International Growth Centre. The IGC is headquartered at the LSE where the grant holder is the Academic Director of this new organization. Our new data sets on district development outcomes in India and Kenya have the additional benefit of allowing future researchers to identify development effects of certain policies that cannot be investigated with cross-country data.

3. EARLY AND ANTICIPATED IMPACTS

a) Summary of Impacts to date

Please summarise any impacts of the project to date, referring where appropriate to associated outputs recorded on *ESRC Society Today*. This should include both scientific impacts (relevant to the academic community) and economic and societal impacts (relevant to broader society). The impact can be relevant to any organisation, community or individual. *[Max. 400 words]*

The impacts of this project to date are: (a) scientific outputs that shape knowledge and future research on the role of infrastructure in development; (b) two new long-run data sets on infrastructure and development outcomes in India and Kenya; (c) influence on related policy discussions; (d) support for PhDs who will continue to contribute to the field.

This project dramatically increases the knowledge and data on infrastructure and development, including new long-run district data sets for India and Kenya submitted to the UK Data Archive. Methodological advances include the applying modern general equilibrium trade framework's predictions to study the impacts of infrastructure on development outcomes (outputs (1) to (3)), and developing econometric techniques to identify these impacts as causal (outputs (1) to (5)). Various scientific papers have been written (see *ESRC Society Today*) and our findings were disseminated through the DFID-funded Research Consortium iiG and the International Growth Centre (IGC), and were presented at seminars and conferences across the globe.

This project's contribution to knowledge of the mechanisms by which infrastructure enhances development also support policy. Findings from the project were discussed by the Indian Planning Commission Committee while considering investments to reinvigorate India's railways. Results on weather and death (output (4)) were presented to the Government of Bihar and the Government of India, shaping debates on climate change impacts in rural areas and how infrastructure can mitigate weather shocks.

Findings from Kenya (output (5)) have a critical impact for development planning by demonstrating that

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ethnic favoritism by African politicians in infrastructure provision may be a key cause of unequal development, and by enhancing evidentiary support for multi-party democracy in Africa. Presentation of these findings at e.g. the TSE/World Bank Conference on Infrastructure Economics and Development also directly impacted the knowledge on which development bank representatives will base future infrastructure financing.

Finally, this project supported PhD researchers who are becoming stars in the infrastructure-development field. Dave Donaldson is considered the best LSE PhD Economics student in a decade and chose MIT among the offers from all top US Economics Departments he received on the basis of output (3). Ameet Morjaria won a prestigious three year post-doctoral position at Harvard on the basis of output (6). Remi Jedwab will be going on the job market this fall with output (7). The future contributions of these students should not be underestimated.

b) Anticipated/Potential Future Impacts

Please outline any anticipated or potential impacts (scientific or economic and societal) that you believe your project might have in future. *[Max. 200 words]*

In order to realize policy impact spillovers, it is of paramount importance that this project's papers be published in leading scientific journals. The majority of the outputs listed above are at various stages on their way to publication.

In parallel to pursuing publication, we continue to encourage a direct impact on policy-making in South Asia and Africa from our findings. Through the International Growth Centre we continue to be in close contact with top policymakers in Delhi, Bihar, Bangladesh, Pakistan, Ghana, Tanzania, Ethiopia, Rwanda, Zambia, Mozambique to whom relevant findings from our analysis will be communicated. We also plan to give presentations to organizations like DFID, the World Bank, the African Development Bank (in their Annual Conference), USAID and IMF. In policy making circles in both South Asia and Africa there is considerable interest in understanding how investments in transportation infrastructure can be harnessed to promote development and to protect citizens from the vagaries of weather.

Examples include the Planning Commission work on upgrading railways in India and the Trans African Highways project which aims to improve African highway infrastructure and boost intra-continental trade, where the findings from our various projects can help inform the types of investments considered.

You will be asked to complete an ESRC Impact Report 12 months after the end date of your award. The Impact Report will ask for details of any impacts that have arisen since the completion of the End of Award Report.

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4. DECLARATIONS

Please ensure that sections A, B and C below are completed and signed by the appropriate individuals. The End of Award Report will not be accepted unless all sections are signed. Please note hard copies are NOT required; electronic signatures are accepted and should be used.

A: To be completed by Grant Holder

Please read the following statements. Tick ONE statement under ii) and iii), then sign with an electronic signature at the end of the section.

i) The Project

This Report is an accurate overview of the project, its findings and impacts. All co-investigators named in the proposal to ESRC or appointed subsequently have seen and approved the Report.	<input checked="" type="checkbox"/>
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ii) Submissions to *ESRC Society Today*

Output and impact information has been submitted to <i>ESRC Society Today</i> . Details of any future outputs and impacts will be submitted as soon as they become available.	<input checked="" type="checkbox"/>
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OR

This grant has not yet produced any outputs or impacts. Details of any future outputs and impacts will be submitted to <i>ESRC Society Today</i> as soon as they become available.	<input type="checkbox"/>
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OR

This grant is not listed on <i>ESRC Society Today</i> .	<input type="checkbox"/>
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iii) Submission of Datasets

Datasets arising from this grant have been offered for deposit with the Economic and Social Data Service.	<input checked="" type="checkbox"/>
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OR

Datasets that were anticipated in the grant proposal have not been produced and the Economic and Social Data Service has been notified.	<input type="checkbox"/>
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OR

No datasets were proposed or produced from this grant.	<input type="checkbox"/>
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