

## A. PROJECT SUMMARY

**Goals.** Advocates argue that road building in low-income nations facilitates market access, promotes economic development, and improves canonical indicators of well-being in the orthodox approach to development. Detractors argue that road building has many ecological and social consequences. A potential explanation for the conflicting positioning on the social effects of road building is that previous research on the topic has relied on observational studies often plagued by well-known biases from the lack of carefully chosen control groups. To improve estimates of the effects of the road on the well-being of indigenous peoples and on their use of natural resources, in the proposed research, we will use a natural experiment based on the construction of a road through a national park inhabited by three native Amazonian groups in Bolivia.

**Specific aims.** (a) Test hypotheses from cultural anthropology about the immediate effects of road building on the well-being and use of natural resources of native Amazonians; (b) Offer to other cultural anthropologists the opportunity to add modules of interests to them for measurement by our research team at baseline and in the two immediate follow up surveys of this research, so third parties can track (at their own cost) their outcomes in the medium and long-run, after this research project ends; (c) Use the research project to train three PhD students in cultural anthropology so they can use project data for their dissertations.

**Methods.** Research will last three years (1/2010-12/2012) and will take place in villages in Parque Nacional Isiboro-Sécure inhabited by native Amazonians (Tsimane', Yuracaré, and Moxeños). The research team includes cultural anthropologists and an economist that have been working together in the area since 1999. The study will include a baseline or pre-intervention study during 2010 (before the road is built) and two annual follow-up surveys (2011 and 2012) immediately after the construction of the road (planned for 2011). The sample will consist of two groups of villagers – treatment and control – which (before the construction of the road) are similar one to each other on observed features. Measures of well-being will include: (a) village income and status inequality, (b) intra-household disparities, and (c) individual cash income, (d) social capital, and (e) emotions. Measures of use of natural resources will include the extraction of natural resources used for sale and for own consumption. We will compare the short-run outcomes of villagers directly affected by the road with those of unaffected villagers.

**Significance.** *Public service to the anthropological community.* This is the first study known to us where researchers offer to collect data as part of a natural experiment for third party researchers so third parties can assess the effects of the experiment on the outcome of interest to them. Road building and the subsequent increase in market exposure likely has immediate, medium, and long-run effects on well-being. Due to the nature of the funding we can only measure the immediate effects of the intervention. But because part of the data collected will be in response to the demand of third parties, this study will provide a priceless repository of data for researchers who might want to assess the medium and long-term effects of the road. The proposed research program will include the training of three PhD students. *Anthropological theory.* The construction of roads through native Amazonian territories has polarized defenders and critics of road building (and development) into two camps about the socioeconomic effects of road building. A single study on such a complex topic cannot bring closure to the debate, but at least it should help to produce a transparent empirical base for it.

## **“Construction ahead”:**

### **The effects of roads on indigenous people’s well-being and use of natural resources. A natural experiment in lowland Bolivia**

**1. Background of previous NSF-funded research.** *Godoy*, an economic anthropologist, has received 15 NSF awards since 1992 to do comparative studies of the effects of economic development on well-being and on the use of natural resources among tropical lowland native Americans and patience and wildlife consumption in Gabon. Results have appeared in a book, over 50 refereed articles (including one in Nature), and two book chapters. In 2003, he organized a workshop with W. Leonard (Northwestern U) on best methods to collect panel data in the behavioral and public-health sciences. Since 2004, he runs a summer school on fieldwork methods for PhD students in cultural anthropology. *Reyes-García* is a cultural anthropologist who received one NSF award in 1999 to do PhD research among the Tsimane’, a native Amazonian group in Bolivia. She used cultural consensus methods to study the effects of markets on changes in ethnobotanical knowledge. Results from this award appeared in her PhD thesis, Science, Current Anthropology, and in four other refereed articles. She has also been co-PI on five other NSF awards (with Godoy, Leonard, and McDade) to do research on the effects of markets on the quality of life of native Amazonians in Bolivia. She is the lead author in over 20 refereed articles. Her research has been featured in The Economist. Godoy and Reyes-García have worked together for over a decade. Godoy and Reyes-García have used experimental research design to study the effects of cultural empowerment on well-being, the effect of village income inequality and income levels on health, and the effect of participatory mapping on encroachment, all among the Tsimane’. *Heffetz*, an economist, teaches at the Johnson Graduate School of Management at Cornell University. He does experimental economics and has done comparative research in the USA and among the Tsimane’ on the cultural visibility of consumption. His research has been featured twice in the New York Times. The three have taught in the NSF summer field training program in methods of data collection for PhD students in cultural anthropology.

## **2. Motivation and aims**

Many developing regions, such as South America, are currently sites of large-scale infrastructure projects, including, but not restricted to, road building (CEPEI, 2002). Road building in low-income nations has fervent advocates and detractors. Advocates argue that road building in low-income nations facilitates market access, promotes economic development, and improves the well-being of people and communities by reducing the costs of spatial mobility for people, capital, and information (Owen, 1987; Vance, 1986). Policy-makers argue that roads bring electricity, cheaper access to medical services, schools, and financial institutions, so roads open up new economic opportunities and therefore should increase income, savings, and consumption, all canonical indicators of well-being in the orthodox approach to development. For example, in 1999 the World Bank published *Poverty Reduction and the World Bank* and argued that road construction in low-income nations would “provide numerous benefits” (p. 58), including enhancing food security and “access to basic education and health services that are essential to reduce poverty” (World Bank 1999).

But the presumptive benefits of road building are contested by many researchers who have documented negative social and ecological impacts of roads (Bunker, 1985; Davis, 1977; Fahrig and Rytwinski, 2009; Forman et al., 2003; Trombulak and Frissell, 2000) and by groups in civil society, including indigenous peoples themselves, who see in road construction more encroachment by outsiders (Mendoza et al., 2007; Schmink

and Wood, 1992). Since the 1960s, researchers have studied the social effects of highway projects in the Amazon. Specifically, a large body of literature on road building in Brazil, Peru, Ecuador, Bolivia, and Venezuela has documented how the opening of roads in the Amazon region results in disorganized land settlement, land concentration, widespread deforestation, invasion of indigenous lands, disordered small-scale mining, and predatory timber extraction (Browder and Godfrey, 1997; Goodland and Irwin, 1975; Hall, 1989; Mäki et al., 2001; Perz et al., 2007; Reid, 2001; Rudel, 1983). Researchers have argued that all the above mentioned factors increase community economic inequality, abrade traditional forms of social capital (e.g., reciprocity), cause social conflicts (via disputes over land and other natural resources and by threatening habitats on which traditional livelihoods depend), increase the incidence of alcoholism, accentuate intra-household disparities, accelerate the loss of indigenous languages and local ecological knowledge, and contribute to the spread of disease (Chomitz and Gray, 1996; Eisenberg et al., 2006; Goodland and Irwin, 1975; Mahar, 1989; Mäki et al., 2001; Perz et al., 2007; Rudel, 1983; Schmink and Wood, 1992; Wunder, 2000). For example, research suggests that in Bolivia, investments in a road from the highlands to the department of Santa Cruz stimulated rapid migration to Santa Cruz (Stearman, 1985), accelerated colonization of the lowlands by highland colonist farmers, and increased interethnic conflicts between highlanders and lowlanders (Paz, 1991). During the 1980s and 1990s, soybean and cattle ranching operations expanded in the department of Santa Cruz (Pacheco, 1998), increasing the amount of forest clearance, particularly along roads (Mertens et al., 2004).

Besides possible ideological posturing, at least two substantive reasons might explain the conflicting positioning on the effects of road building. First, previous research has relied on observational studies (Goodland and Irwin, 1975; Mäki et al., 2001; Rudel, 1983; Schmink and Wood, 1992). Observational studies are plagued by well-known biases from the lack of carefully chosen control groups. For example, the placement of roads in areas with rich natural resources or in areas that benefit privileged groups – such as roads built in Brazil, Argentina, and Bolivia to lower the costs of commercial soy bean production – might seem to improve local well-being. But improvements in outcomes might just have to do more with the characteristics of the people privileged by the road than with the benefits of the road itself. Second, the timing over which researchers measure effects matters. Access to roads might have positive immediate (short-run) effects on indicators of material well-being, but might (or no) have negative medium or long-run effects. For example, a road might increase monetary income in the immediate-run because people can sell readily available natural resources, but the depletion of those resources might produce lower monetary income in the long-run if people must continue to depend on the use of natural resources for their income.

To overcome the two problems just discussed, a team of cultural anthropologists (Godoy and Reyes-García) and an experimental economist (Heffetz) proposes to conduct research using a natural experiment about to take place in the Bolivian Amazon. For reasons discussed later, the Bolivian Government has decided to build a road through a national park inhabited by native Amazonians, Territorio Indígena Parque Nacional Isiboro-Sécure, hereafter TIPNIS. We will use the construction of the road – from its planning phase (first half of 2010), through construction (first half of 2011), and the two years after the completion of the road (second half of 2011 and 2012) -- to estimate the effects of the road on *changes* in the well-being of indigenous peoples and on their use of natural resources. The study will start by selecting two groups of villagers before the construction of the road – treatment and control – which are similar one to each other on the outcomes of interest. This assessment will ensure that the treatment (construction of

the road) is hence as good, for our purposes, as a randomly assigned treatment. We will compare changes in the outcomes of villagers directly affected by the road with changes in the outcomes of villagers unaffected by the road.

The natural experiment will allow us to identify causality and to make more precise estimates about the effects of road building on the well-being of indigenous peoples and on their use of natural resources than one could obtain from observational studies. The study will unfold over three years, a baseline or pre-intervention study during 2010 and two annual follow-up surveys (October – December, 2011 and 2012) immediately after the construction of the road (planned for 2011). Because the proposed research will last for just three years, we will only be able to estimate the immediate or short-run effects of the road, but we will make available the baseline study to the general public so other researchers can later estimate medium and long-run effects.

We propose to use the natural experiment to achieve the following aims:

- Test hypotheses from cultural anthropology about the immediate effects of road building on the well-being and on the use of natural resources of native Amazonians;
- Offer to other cultural anthropologists unaffiliated with this research project the opportunity to add modules of interests to them for measurement by our research team at baseline and in the two follow up surveys. In this way, third party researchers will be able to track their outcomes not only while the project lasts, but also – with their own funding -- in the medium and long-run, after this research project ends; and
- Use the research project to train three PhD students in cultural anthropology so they can use project data for their dissertations.

### **3. The ethnographic context**

In 2008, the President of Bolivia, Evo Morales, announced the construction of a road linking the city of San Ignacio de Moxos, Department of Beni, with the town of Villa Tunari, Department of Cochabamba, in the tropical region of the Chapare, the heartland of Bolivia's commercial coca production. The 360-km road will pass through eight towns, will be seven meters wide, and will include 16 bridges. The road, which has the ultimate goal of linking the city of Cochabamba in the highlands with the city of Trinidad in the lowlands, will cut through TIPNIS, a national park and an indigenous territory inhabited by three groups of native Amazonians: Tsimane', Yuracaré, and Moxeños. The Government of Brazil has pledged US\$300 million to pay for the construction of the road. On August 4<sup>th</sup>, 2008 the Administradora Boliviana de Carreteras (ABC), representative of the Bolivian Government, signed a contract for the design and building of the road with the Brazilian company OAS Ltda. To provide the context for the natural experiment, in the balance of this section we provide background ethnographic information on the region and the principal stakeholders.

#### *3.1. TIPNIS: Origins.*

The National Park Isiboro-Sécure (NPIS) covers an area of about 12,000 km<sup>2</sup> and is situated in the province of Chapare, department of Cochabamba. The park was created in 1965 and affected an area inhabited by semi-nomadic Tsimane', Yuracaré, and Moxeños (Vandebroek et al., 2004a). The physical inaccessibility of NPIS helped to maintain the area free from outsiders until 1970. Starting in 1970, highland Quechua colonists from rural villages and mining centers migrated from the highlands to colonize part of the NPIS.

Colonization by highlanders intensified during the early 1980s in response to the structural adjustment program and the closing of some of Bolivia's largest state-owned mines. Miners flocked to the Chapare, pushed by the lack of economic opportunities in the highland and lured by the prospect of earning higher income from coca production (De Franco and Godoy 1992). The increasing presence of highlanders in the lowland region fuelled a reaction among lowland indigenous groups in defense of their territory. In 1990 lowland indigenous groups organized a peaceful march to the capital city of La Paz to demand government recognition of their territorial rights. In response to the massive protests by lowland indigenous peoples, the Bolivian government declared part of the National Park Isiboro-Sécure as an indigenous territory for the three lowland indigenous groups inhabiting the area (D.S. N°22.610). The new territory became known as the Territorio Indígena-Parque Nacional Isiboro-Secure (TIPNIS).

### *3.2. Highland and lowland indigenous cultures in the TIPNIS.*

At one level, the construction of the road could be read as the latest manifestation and part of a broader backdrop of a highland-lowland division that has marked Bolivian history for much of the last two centuries (Stearman, 1985).

At present about 6,000 lowland indigenous people and about ~30,000 highland colonists live in TIPNIS. Interviews with representatives of non-government organizations working in the area suggests that the number of colonists living in TIPNIS has grown from ~10,000 in 1994 to ~30,000 at present. Native Amazonians mostly live along the rivers Isiboro and Sécure, within the limits of the indigenous territory, whereas highland colonists, who are illegal but tolerated occupants, are mostly settled in the area outside the indigenous territory but within the national park.

In part because they have historically inhabited the same territory, Yuracaré, Tsimane', and Moxeños in the TIPNIS display many similarities in cultural orientation and in material lifestyle. For example, Tsimane', Yuracaré, and Moxeños are relatively isolated, with tenuous contacts to the market economy or to national politics. The main economic activity of the three groups consists of slash-and-burn farming, supplemented with fishing, hunting and, to a lesser extent, collection of edible forest products. The main crops include banana, manioc, and rice. Sporadically they sell salted game, fish, rice, and canoes, or work for wages for Quechua farmers who live at the borders of the indigenous territory (Vandebroek et al., 2004b). But the three groups also differ in two fundamental respects. First, Moxeños, more so than Yuracaré or than Tsimane', had sustained contact with Jesuit missionaries for centuries, contact that has changed their livelihood strategy. Thus, Moxeños tend to rely on small-scale cattle-raising more than Tsimane' and Yuracaré, who favor hunting, fishing, and slash-and-burn farming. Second, Yuracaré and Tsimane' are traditional inhabitants of the area, whereas Moxeños arrived from the Moxos (Beni) only at the end of the 19<sup>th</sup> century, during the commercial rubber boom and the invasion of their territory by outsiders for commercial purposes. Migrations took place as part in the millenarian movement of the Loma Santa (Lehm, 1991). Inspired by a vision of the future stocked with abundant resources but without outsiders or the trappings of the Western world, Moxeños who have this vision abandon all commercial goods and their village of residence and move farther into the backlands. This process of migration was aimed at a reoccupation of the space they occupied in the pre-colonial period and implied a revival of their culture. Moxeños arrived to the TIPNIS during the 1930s through this migration. In contrast to the Moxeños, the Yuracaré and the Tsimane' have a long tradition of evading missionaries and other westerners and moving farther into the backlands into more inaccessible regions.

Highlanders living in the TIPNIS are mostly Quechua, with some Aymara speakers. They are well organized in a variety of peasant unions and receive tacit and explicit support from the national government in part because the current President of Bolivia, Evo Morales, was himself a labor leader in the coca-growing region and more specifically the representative of colonists in TIPNIS two decades ago.

Lowlanders relate well to each other (historically they were neighbors), but they have conflicts with highlanders, mostly in relation to their social organization, land use, and land tenure (Paz, 1991). Highlanders view the lowlands as a reservoir of empty land, ready for possession, and view lowlanders as people lacking in motivation and a strong work ethic. Lowlanders view highlands as aggressive intruders, although possessed with entrepreneurial skills. Despite cultural differences, lowland and highland groups in the TIPNIS depend on each other. For example, lowland native Amazonians often prefer to go to lowland towns with a heavy presence of Quechua and Aymara shop owners because they feel they receive a fairer treatment than they do when visiting lowland towns predominantly inhabited by white traders. Lowland indigenous groups value and use highland indigenous medicines and medical treatments, while Quechua and Aymara speakers rely on the knowledge and acumen of lowland indigenous groups to extract natural resources. With the building of the road, we expect many Quechua (and to a lesser extent, Aymara) speakers currently living in the coca-growing Chapare area abutting the national park to move into the park. The complex cultural tapestry of the region and the interdependence of highland and lowland indigenous cultures in the TIPNIS provide the cultural stage in which the experiment will unfold.

### *3.3. The stakeholders.*

*3.3.1. Advocates for the road.* Some in Bolivia argue that the road has been explicitly designed to accelerate the movement of landless highlanders and coca cultivators into the lowland areas, particularly now that Bolivia faces fiscal constraints from declining revenues from oil and gas production. President Evo Morales endorses the construction of the road because it responds to the demands of some of his most loyal and numerous supporters. The government of Brazil and a Brazilian construction company will finance and build the road. Other advocates for the road include loggers, cattle ranchers, and oil firms, who now rely on expensive methods of transport to explore the territory. Oil and gas companies have done exploration work in the TIPNIS since the 1990s, and logging firms have started to extract logs from the area, albeit in small amounts. Cattle ranchers and logging firms want the road to lower their costs of production and widen their access to markets. The Coordinadora del Colonos del Trópico de Cochabamba, a labor union of rural workers in the tropical Cochabamba, has lobbied for the road because it sees it as a way to lower land pressure in the region of Cochabamba and gain access to untapped natural resources and new markets.

*3.3.2. Detractors of the road.* Critics of the road include the three native Amazonian groups in the area through their representatives. In the TIPNIS one finds three organizations of lowland indigenous groups: 1) Subcentral Indígena del Isiboro Sécuré which represents indigenous groups in the entire area, 2) Consejo Indígena del Sur, which represents the communities in the southern part of TIPNIS, and 3) Subcentral Sécuré, which represents the indigenous groups along the Sécuré river. The three organizations have opposed the road because they see it as a threat to their territory. Other detractors of the road are international non-government organizations working in the area in public health, education, and conservation (e.g., Solidaridad Medica Canaria, CIDEBENI, Conservation International), and some local institutions affiliated with the Catholic Church.

## 4. Research strategy

### 4.1. *Identifying causality through a natural experiment.*

Researchers in the behavioral sciences have often used natural experiments to estimate causal effects. In a natural experiment researchers exploit an exogenous event (e.g., a new policy, a natural disaster) to estimate changes in an outcome from the event. Because affected people had little or no control over the event, the event is exogenous to them, and one can use the event to strengthen the basis for making inferences about causality. To estimate the effect of the exogenous event, researchers make two comparisons. First, they compare the outcome or dependent variable before and after the event. Second, they compare changes in the dependent variable between the group affected by the event (the treatment) and the group unaffected by the event (the control). For example, in 1992 the state of New Jersey raised the minimum wage, while Pennsylvania did not. In a classic study, Card and Krueger (1994) used the policy change to assess whether the increased minimum wage increased unemployment in New Jersey compared with Pennsylvania. They did so by comparing changes in unemployment rates in New Jersey with Pennsylvania before and after the policy change. Other examples of recent use of natural experiments include changes in the use of language of instruction in public school on earnings (Morocco) (Angrist and Lavy, 1997) or language fluency (Puerto Rico) (Angrist et al., 2006), and changes in traffic laws in New York to assess corruption (Fisman and Miguel, 2008). To our knowledge, cultural anthropologists have rarely used natural experiments (Bernard, 2005).

### 4.2. *A natural experiment in the department of Beni, Bolivia.*

The proposed road construction provides a nearly ideal natural experiment. We equate the road with the treatment, so villages and villagers directly exposed to the road will be the treatment group and those unaffected (or only very indirectly affected) by the road will be the control group.

We propose to use three types of controls. First, we will collect the same information both in villages directly affected by the road and in villages not directly affected by the road. Second, we will use the timing of the intervention to identify villages that will be directly affected by the road first (treatment) and villages that will be directly affected by the road, but only later (control). Third, we propose to use isolated Tsimane' villages in a nearby territory (Territorio Indígena Tsimane') that will be completely unaffected by the road since they lie in a different river basin (Maniqui) an entirely outside of TIPNIS. We will use this third type of control to redress the possibility that the road building might affect all villages and people in TIPNIS. For this last comparison, we will first demonstrate that there are no observable differences between Tsimane' in the two territories (TIPNIS and Territorio Indígena Tsimane').

### 4.3. *Hypotheses about socio-cultural effects.*

Due to the duration of the study, we can only formulate hypotheses about the **immediate** (or short-run) effects of road construction, and due to the composition of the research team, we can only test hypotheses about the effects on socio-cultural outcomes. We are fully aware that the construction of the road will also affect other outcomes such as health (Eisenberg et al., 2006) and will also have medium and long-run effects. We focus on immediate socio-cultural outcomes owing to budget constraints and to the composition of the research team. The hypotheses we propose capture the expected effects of the road on different levels of socio-cultural organization: ethnic groups, villages, households, and individuals.

Effect of the road on ethnic groups:

H1: News about the construction of the road will generate self-selective migration. All else held constant, we expect Yuracaré and Tsimane' to be more likely to leave villages planned to be directly affected by the road even before the road is built because they have a cultural tradition of eschewing modernization. As we explain later, to test this hypothesis we will collect data on recent migration out of the community in the baseline study and try to track the people who moved out in anticipation of the road.

Effect of the road on villages:

H2a: Village homogeneity in ethnic composition and monetary income will provide better coping mechanisms against the possible stresses induced by road construction, than village heterogeneity in ethnic composition and monetary income disparity. We expect that village-level homogeneity in ethnic composition and monetary income will attenuate the adverse effects of the road on well-being – while not attenuating the positive effects – because previous research in industrial nations and among the Tsimane' suggests that village income inequality might harm social capital (Brabec et al., 2007). Village-level social capital, in turn, should help protect households from adverse changes in income or consumption levels.

H2b: Compared with villages in the control group, villages affected by the road will experience increased village inequality in monetary income and status. (Notice that H2a and H2b can be tested separately. Also notice that the two might interact with each other, giving rise to a compound effect.)

Effects of the road on households:

H3: Compared with households in the control group, households in villages directly affected by the road will experience an increase in intra-household disparities in monetary income because roads will likely increase economic opportunities for males over females and for young over old, thereby increasing the economic gap between spouses and between generations.

Effects of the road on individual well-being:

Compared with villagers in the control group, people in villages directly affected by the road will experience the following:

H4a: Higher growth rates in monetary income because the road will open up economic opportunities.

H4b: Sharper decline in traditional forms of individual social capital (e.g., reciprocity) because such forms of self insurance will start to be replaced by modern forms of self-insurance (e.g., informal credit). (See also the related hypotheses H2a and H2b.)

H4c: Higher incidence of negative emotions such (e.g., envy, jealousy) because exposure to the road will increase community monetary income and status inequality (hypothesis H2b).

Effect of the road on the use of natural resources:

Compared with villagers in the control groups, villagers in the treatment group will:

H5a: Increase the rate of extraction of natural resources they can sell (e.g., logs) because road opening will increase the relative price of exportable products (e.g., logs) relative to goods that only enter the village economy (e.g., medicinal plants).

**H5b:** Lower the rate of extraction of natural resources without a demand beyond the village economy (e.g., medicinal plants) because they will be replaced by commercial goods (e.g., industrial medicines).

#### 4.4. The research design

Table 1 contains a summary of the proposed research design. In Table 1 we show two groups, each depicted in a separate column: the treatment group (T; column II) and the control group (C, column III). The treatment for the natural experiment consists of the construction of the road. The treatment group consists of villages close to the proposed path of the road. The control group consists of villages that will not be directly affected by the road, with the caveats noted earlier. In Table 1, the row ‘Before’ refers to the time before the road (or our first survey) and the row “After” refers to the period after the building of the road (second and third surveys). The estimates within each cell refer to the average outcome before and after road construction, for treatment and for control groups. To fix ideas, we use cash income (I) as an outcome in Table 1.

Table 1. Summary of research design with cash income as an example of outcome:

[I]	[II]	[III]	[IV]
<b>Time:</b>	<b>Groups in natural experiment:</b>		$\Delta$ (Treatment-control)
	<b>Treatment</b> (Villages affected by the road)	<b>Control</b> (Villages unaffected by the road)	
<b>Before the road</b>	Cash income ( $T_{BI}$ )	Cash income ( $C_{BI}$ )	$(T_{BI}-C_{BI})$
<b>Treatment=building of the road</b>	<i>Road close to the village</i>	<i>Road far from the village</i>	
<b>After the road</b>	Cash income ( $T_{AI}$ )	Cash income ( $C_{AI}$ )	$(T_{AI}-C_{AI})$
$\Delta$ (After- before)	$(T_{AI}-T_{BI})$	$(C_{AI}-C_{BI})$	<b>Difference in difference:</b> $(T_{AI}-T_{BI})-(C_{AI}-C_{BI})$
Notes: T= treatment, or individuals in villages affected by the road. C=control, or individuals in villages unaffected by the road. B= period before road construction. A=period after road construction. I= outcome measured (e.g., cash income)			

The cell called ‘difference-in-difference’ captures the net effect of the road on changes in levels of the selected outcomes between the treatment and the control group before and after the construction of the road,  $(T_{AI}-T_{BI})-(C_{AI}-C_{BI})$ . A negative number in the cell implies negative effects on the selected outcome (e.g., a decline in cash income), a positive number implies a positive effect, and an estimate close to zero implies no visible changes in the selected outcome between people living in villages affected and unaffected by the road. The cell under column IV captures the difference between the treatment and the control group at baseline ( $T_{BI}-C_{BI}$ ) and should be close to zero to ensure treatment and control are as similar as possible before the building of the road.

#### 4.5. Possible threats to internal validity.

4.5.1. *Assessing possible sample selection bias before road building.* We care about possible selectivity biases from migration because news about the road might generate in and out migration from people with selected characteristics. For example, because the design of the road started during 1999 and its building has been officially announced, people might have already started to change their behavior. It is possible that some people with a long tradition of avoiding market exposure might have already migrated to remote villages that will be unaffected by the road whereas people with a higher propensity to move toward the market economy might have already migrated to more accessible villages. If so, estimates of changes in well-being and on the use of natural resources relying only on the people present in affected villages at the time of the baseline study would exclude people who left in anticipation to the road, and thus produce flawed conclusions about the marginal effects of road building. Therefore, part of our study will center on assessing migratory patterns in the region since the official announcement of the road construction.

4.5.2. *Assessing the similarity in outcomes between treatment and control groups.* The internal validity of our natural experiment design hinges on the similarity in outcomes of people in the villages affected and unaffected by the construction of the road. For example, suppose that treatment and control groups differed in outcomes before the road building. Then growth rates in outcomes of treatment and control groups might differ owing to differences in initial conditions, not to the road building. To address the concern, we will select villages based on a matching strategy: each village in the treatment group will be matched with another village, as similar as possible, in the control group. To verify successful matching, during the baseline survey we will assess the socioeconomic comparability of treatment and control groups and adjust the control group accordingly. Note that *intra-group* differences are expected and indeed welcomed as they reflect the heterogeneity of each group (control and treatment) and hence enhance the external validity of the research. For example, we expect Moxeños to differ in the propensity to respond favorably to the road, even at baseline.

4.5.3. *Assessing the reasons for the construction of the road.* In this proposal we treat the construction of the road as an exogenous event to native Amazonians in the TIPNIS, but the pathway of the road was not selected at random. The government likely had reasons to select the proposed pathway for the road. Suppose, for example, that some villages or stakeholders wanted the road to be built along certain parts of the national park because it benefited them, and that the government planned the road accordingly in response to their demand. If so, then the placement of the road would not be exogenous. For this reason, during the ethnographic stage of this research we will document the process that lead to the final decision of road placement. When choosing villages into both the control and the treatment groups, we will make sure that from the point of view of their villagers, the road construction was as exogenous as possible.

#### 4.6. Possible threats to external validity.

Tsimane', Yuracaré, and Moxeños in the TIPNIS are relatively typical of other native Amazonian societies but they differ from many native Amazonian societies in that they live at the foothills of the Andes and so have experienced influence from Quechua and Aymara groups. Furthermore, as noted earlier, even within the proposed research site we find cultural differences between the three ethnic groups. For these reasons, results of the proposed study will likely apply only to some native Amazonian societies, probably those at the foothills of the Andes.

## 5. Methods

Research will unfold in three stages. In Table 2 we summarize the proposed methods of data collection and sample size for each of the three stages of the study. We have used most of the methods proposed here in a panel study in progress among the Tsimane' living in an adjacent zone (Territorio Indígena Tsimane'), but we need to adapt the methods we have used in the past to the new area.

Table 2. Methods of data collection and sample

<i>Stage</i>	<i>Dates</i>	<i>Data collection method</i>	<i>Sample</i>
First	Jan-Feb '10	Village census	Tsimane', Yuracaré, and Moxeños villages in PNIS
	Jan-Sep '10	Archival research and institutional ethnography	Institutions to be identified
	Mar-Sep '10	Village ethnography	Six villages
Second	Oct-Dec '10	Baseline survey for treatment and control communities	All treatment villages and equal # of control villages. All households & people $\geq 16$ years
	Oct-Dec '10	Tracking and applying baselines survey: pre-atrifiers*	Unknown sample size
<b><i>Road building: 2011</i></b>			
Third	Oct-Dec '11 Oct-Dec '12	Two annual post-intervention surveys	All treatment villages and equal # of control villages. All households & people $\geq 16$ years
	Oct-Dec '11 Oct-Dec '12	Tracking and applying post-intervention surveys to attriters	Unknown sample size
	Feb-Mar '11 Feb-Mar '12	Short post-intervention survey during rainy season	10 randomly selected households/village

\*Pre-atrifiers = people who leave villages of the study in anticipation of road. Attriters = people who leave sample after baseline study.

### 5.1. – Data collection methods and sample sizes by stages.

#### First stage

*Call for modules:* As soon as we hear from NSF about the funding decision, we will send an open call to add socio-cultural modules to the baseline survey. We will circulate the call to all faculty in anthropology departments with a PhD program in the USA and to the e-mail list of Anthro-Science. We will review the requests and during the first year we will pilot test the modules. We will make a final decision on what modules to include based on the costs of the modules, on the overlap with the proposed research, and on the qualifications of the researchers in this project to pilot test and collect reliable information on the outcomes of interests to third parties. Our research team will collect the requested data for third parties. In so doing, we will allow the broader anthropological community to own the natural experiment since some of the topics of interest to them will be included in the study at a cost to the project.

*Village census and survey of village attributes:* We will start fieldwork by conducting a baseline village-level census and survey among all the Tsimane', Yuracaré, and Moxeños villages in the TIPNIS. Preliminary evidence suggests that there are about 45 villages in the TIPNIS or about 1500 households: five Tsimane' villages (~500 people), about 20 Yuracaré villages (~3000 people), and about 20 Moxeño villages (~3000 people). The village census will include the name, sex, ethnic affiliation, and ages of all the people in each village. At this stage we will ask the new residence of people who moved from the villages in response to the announcement of the road construction and identify recent migrants into the village. We will try to find the people who left so we can include them in the baseline survey to test hypothesis #1. The village census will help us to select the sample size of villages, households, and individuals for the second stage of research.

*Archival research and institutional ethnography:* To get information on the perspective of different stakeholders, such as national and local (municipal) governments and local and international NGOs, during the first stage of the project we will collect ethnographic and archival materials (e.g., newspapers, reports, official documents). Through interviews, we will ask stakeholders their views about the expected benefits and costs of the road – both in the short- and long-run – the reasons for the placement of the road, and any actions they have taken to oppose or promote the building of the road.

*Village ethnography:* We will use the village census to select two Tsimane', two Moxeño, and two Yuracaré villages to conduct a baseline ethnographic study. For each of the three ethnic groups, one village will be in the treatment group and one village will be in the control group. We will assign one graduate student to each ethnic group for 18 months of participant observation and systematic ethnographic data collection. Information during the ethnographic stage will be collected through informal in-depth, open-ended, and semi-structured interviews. Students will be fluent in Spanish and will be expected to study the indigenous language of the group. Where necessary, they will work with local translators, drawing on our experience in training and collaborating with indigenous translators in the area over the last 15 years.

The main goal of the ethnographic phase is exploratory: among the many possible outcomes we have selected, ethnography should tell us which ones matter most in this context. The ethnography is therefore a way to specify the hypotheses in locally relevant terms. For example, we hypothesize that road building will be associated with declining psychological well-being. From the ethnography, we will be able to determine which indicator of psychological well-being matters most for people in the area (e.g., envy, alcoholism, jealousy, loneliness). The more specific goals of the ethnography will be: (1) to describe variation within and between villages on selected outcomes of the natural experiment (see below); (2) to elicit villagers' perceptions of the new road and contact with outsiders; (3) to understand, in-depth, the immediate impacts of the road on life in the villages; (4) to frame culturally appropriate questions that capture variables of interest in the natural experiment; (5) to gain a better understanding of Yuracaré and Moxeño culture (particularly as they relate to the outcomes of interest) since we have only a superficial understanding of these groups (Godoy et al., 2005a; Godoy and Contreras, 2001). For example, during the ethnographic phase we will ask about the most important sources of monetary income in the village, seasonality of income sources, and differences in sources of income between men and women, the young and old.

In sum, ethnography will be invaluable in providing in-depth, qualitative understanding of the process, particularly people's reactions, feelings, thoughts, and discourse about the road, before, during, and after its construction.

## Second stage

*Baseline survey:* The baseline survey will cover the following: (a) all villages in the treatment group, (b) an equal number of villages in the control group, and (c) all households and people in treatment and control villages. Since we will have village-level data from the first stage, the baseline survey will focus on the collection of household- and individual-level data. The household-level survey will include variables common to the household, such as housing material, proximity to water sources, and area of forest cleared for agriculture. The individual-level survey will have two broad parts: (a) basic demography (e.g., age), human capital (e.g., schooling, language fluency), anthropometric measures of short and long-run nutritional status (e.g., height, weight), perceived recent illness (<2 weeks) that will apply to all people and (b) modules on socioeconomic attributes such as monetary income, monetary expenditures, social capital, wealth, or amount of natural resources extracted. The modules on socioeconomic attributes will apply only to people  $\geq 16$  years of age since native Amazonians of the region tend to form independent households on or about that age.

We lack census data about the indigenous peoples in the proposed research site, but data from our research in progress among the neighboring Tsimane' suggests that a typical village has about 25 households, each composed of about three adults ( $\geq 16$  years of age) and three children. We have detected no imbalances in sex ratios at any age. If roughly the same demographics apply to the TIPNIS, and we carry out the survey in all TIPNIS villages ( $n=45$ ), then we will have  $\sim 1125$  households ( $45 \text{ villages} * 25 \text{ households/village} = 1125 \text{ households}$ ) and  $\sim 6750$  people ( $1125 \text{ households} * 6 \text{ people/household} = 6750 \text{ people}$ ), probably evenly split between children and adults, women and men. Since the intervention affects villages, the proposed sample size has to be weighted or clustered at the village level.

The baseline survey will allow us to formally test whether villagers in treatment and control communities differ significantly in key outcomes before the road building.

*Tracking and applying baseline survey to pre-atriters:* Recall from the earlier discussion that the observed sample in the treatment and control group might be biased if people left or moved into the sample in anticipation to the road. We use the term "pre-atriters" for people who left the sample before the start of the study, to differentiate them from people who leave the study after it started (atriters). We can collect data on people who moved into the sample during the study, but we need to track and find people who moved out before we arrived. We split potential pre-atriters into two groups: hard pre-atriters or people who move far away and are costly and difficult to find and soft pre-atriters or people who moved to nearby areas. Since Tsimane' and Yuracaré are highly endogamous we can easily identify the location of people who have moved out from relatives who remain in the village. This said, how many soft and hard pre-atriters we can find will depend on their absolute number and on the costs of reaching them. During 2006, we tracked atriters from the panel study in progress among the Tsimane' in the Maniqui basin (Territorio Indígena Tsimane') and were able to find a high share of the hard atriters, but chiefly because most of them had moved to a few, albeit distant locations. It is an open question how many pre-atriters (if they exist) we will be able to find but we are confident that the method we have used in the past among the neighboring Tsimane' will work in the proposed study site. Once we find atriters, we will apply the baseline survey described in the previous section, but add open-ended questions about why they left.

### Third stage

*Post-intervention survey:* To enhance the accuracy of comparisons between outcomes measured before and after the intervention, we will not change the wording or question order of the survey during the post intervention phase. We will measure outcomes twice, once during October-December 2011, immediately after the construction of the road. This survey will allow us to measure very immediate effects. The second post-intervention survey will take place a year later, during October-December 2012. The second survey will allow us to estimate slightly delayed effects, albeit still relatively short-term. We decided not to do a post-intervention survey during the main rainy season (December-April) to reduce costs, to retain fidelity to the season in which the baseline survey was done, and because none of our hypotheses deals with the seasonality of the effects. However, we will apply a short survey to only 10 randomly-selected households per village during February-March of each of the two post-intervention survey waves. These additional data will be used only to test for differences in outcomes between seasons, but will not be included in the main analysis.

#### 5.2. Measure of variables.

The outcomes measured relate directly to the hypotheses. Because the key explanatory variable – the construction of the road – is exogenous to the individual, we can focus the methods to collect data on the outcomes, but we will collect data on selected control variables for reasons we will discuss shortly.

##### 5.2.1. Outcome variables

*H2a and H2b.* We will assess village ethnic composition by the share of people in a village belonging to different ethnic groups and we will calculate Gini coefficients of village income inequality based on both individual and household measures of monetary income, as we have done in previous publications (Godoy et al., 2005b; Godoy et al., 2006). To measure social status we will ask villagers to name (separately) the most important females and males in the village and assess status by the number of nominations a person receives. We have used this method to estimate village status inequality in the past (Reyes-García et al., 2009).

*H3.* We will collect data on monetary income from all people over 16 years of age, particularly the female and the male heads of the household. We will ask about all monetary income earned during the 14 days before the day of the interview and note the sources (e.g., sale of forest or farm goods, wage labor). Besides collecting data on monetary income earned during the last 14 days, we will ask about government transfers. At present, rural people in Bolivia receive a number of government transfer payments, including retirement payments and payments for sending children to school. Note that measures of monetary income will also be used to compute indices of village income inequality and to test hypothesis H4a.

*H4.* This hypothesis centers on three outcomes, all measured at the individual level: monetary income (described in the previous paragraph), traditional forms of social capital, and negative emotions. We equate traditional forms of social capital with the most ubiquitous forms of sociability among native Amazonians: (a) participation in group drinking of chicha (the fermented beverage produced by households and consumed in group settings), (b) receiving and giving gifts, (c) giving and receiving labor help from others, and (d) borrowing physical assets (e.g., pots, metal axes) from others. For all these outcomes we will ask about the person who received or supplied the gift or labor help. This will allow us to assess the amount of inter and intra village reciprocity. For outcomes (a)-(d) we have found that a one-week recall period produces

reliable data. In current research in progress as part of the panel study, we elicit data on negative emotions by asking about the frequency of anger, fear, and the like during the seven days before the day of the interview. This said, we have never asked about negative emotions associated with increased income inequality, such as resentment, envy, jealousy, and a sense of grievance. It is possible that the simple questions we ask so far might work in the TIPNIS, but we intend to use much of the ethnographic phase to explore how best to elicit reliable information on these psychological outcomes.

*H5.* We will ask about the type and amount of timber sold in the last two months, and the amount of valuable non-timber forest goods (e.g., thatch palm, timber, fish, game) extracted during the week prior to the interview. The extraction and sale of timber is a salient event and we have found that people recall relatively well the amounts extracted during the last two months. The extraction and sale (or consumption) of non-timber forest goods tends to be less salient in part because it takes place all year, entering the household in modest amounts. As a result we have found that a shorter recall period of only one week produces more reliable information for these forest goods.

*5.2.2. Control variables.* We will include control variables for two main reasons to: (a) test the randomness of the intervention at baseline and to (b) test for heterogeneity of average effects within the sample even if the treatment is assigned at random. To address (a) we will measure village-level variables likely to have influenced the placement of the road (e.g., village population size, ethnic composition, average village income, village-to-road distance). To address (b) we will collect detailed demographic data at baseline (e.g., age, sex, household composition, ethnic membership) since the road might affect some groups more than others.

### *5.3. Data analysis.*

During the first stage of data analysis we will assess the randomness of the intervention by regressing outcomes against the treatment at baseline and assessing whether the coefficient of the treatment dummy variable at baseline is indistinguishable from zero. Since we have many outcomes, it is possible that for some outcomes the treatment will not be randomly assigned, but for other outcomes we will see more negligible impacts. We will then focus on the outcomes with the weakest association to the treatment at baseline for the second stage of the analysis. During the second stage, we will regress the best outcomes against a treatment dummy, a before-after dummy variable, and an interaction term of treatment\*before-after, or difference-in-difference estimator. The regressions will be run with clustering by village since road construction affects villages (and people and households, but only through their village residence).

## **6. Personnel**

The research will be done by Godoy, Reyes-García, Heffetz, with a sub-contract to Huanca, the President of the Centro Boliviano de Investigación Socio-Integral (CBIDSI), a non-government organization that works in applied and basic research among native Amazonian groups in Bolivia. Godoy, Reyes-García, and Huanca have over a decade of nearly continuous research experience among the Tsimane' as part of the Tsimane' Amazonian Panel Study. Heffetz has collaborated with the rest of the team testing hypotheses about the cultural visibility of consumption and has participated in the NSF-summer field school for PhD students in cultural anthropology. We will recruit three PhD students in cultural anthropology, who will do fieldwork during the first 18 months of the project and will use project data for their dissertation.

## 7. Broader significance

*Public service to the anthropological community.* This is the first study known to us where researchers offer to collect data as part of a natural experiment for third party researchers so third parties can assess the effects of the experiment on the outcome of interest to them. Road building and the subsequent increase in market exposure likely has immediate, medium, and long-run effects on well-being. Due to the nature of the funding we can only measure the immediate effects of the intervention. But because part of the data collected will be in response to the demand of third parties, this study will provide a priceless repository of data for researchers who might want to assess the medium and long-term effects of the road. The proposed research program will include the training of three PhD students.

*Anthropological theory.* The construction of roads through native Amazonian territories has polarized defenders and critics of road building (and development) into two camps about the socioeconomic effects of road building. A single study on such a complex topic cannot bring closure to the debate, but at least it should help to produce a transparent empirical base for it.

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