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Forced Migration and Changing Livelihoods in the Brazilian Amazon*

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Abstract

Forced migration due to development projects or environmental change impacts livelihoods, as affected households are faced with new—and often less favorable—environmental, social, and economic conditions. This article examines changing livelihood strategies among a population of rural agricultural households displaced by the Belo Monte Dam in the Brazilian Amazon. Using longitudinal data, I find that many households used compensation payments to concentrate income generation efforts on the most lucrative strategies—cacao and cattle production and business or rental income. Poorer households and those that received the least compensation were more likely to continue relying on agricultural wage labor—a less desirable income source associated with not owning land or with persons needing to supplement income with additional work as a day laborer. Results also indicate that the amount of compensation received by most households was sufficient to enable them to make productive investments beyond attaining replacement land and housing. Many households invested in assets such as agricultural infrastructure, cattle, rental houses, or tractors—all of which directly contribute to future income. Displacement compensation, similar to remittances or conditional cash transfers, can therefore act as an important infusion of capital to promote socioeconomic development and poverty reduction.

Introduction

Development-induced forced migration is characterized by the permanent relocation of households due to the construction of large-scale infrastructure such as dams, mines, and urban redevelopment projects. Displaced communities face the task of restoring livelihoods amid new geographic, environmental, social, and economic conditions, and this challenge can leave the affected population impoverished in the wake of otherwise economically beneficial development projects (Cernea and McDowell 2000; Scudder 2005). The risk of impoverishment is generally caused by inadequate investments in the compensation or resettlement program (Cernea 2008; de Wet 2006). While many past studies of development-

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induced displacement found that inadequate resettlement investments resulted in livelihood decline (de Wet 2006; Scudder 2005), a number of examples of successful relocation programs exist (Cernea and McDowell 2000; Mejia 2000; Partridge 1993; Picciotto, Van Wicklin, and Rice 2001). These cases illustrate that adequately funded and implemented resettlement programs—which have historically been the exception rather than the norm—can in fact lead to positive livelihood outcomes among affected communities.

Forced migration due to dam building is a particularly important issue in Brazil. Hydropower has been a central component of the country's energy policy for nearly 70 years and now provides 65 percent of its domestic electricity supply (Alves, Nascimento, and Mesquita 2009; Ministério de Minas e Energia 2014). Brazil has constructed over 500 large dams since the 1950s (International Rivers 2012), and existing dams in the country have flooded 3.4 million hectares of productive land and displaced more than 1 million people (Zhou and Oliveira 2007). The Brazilian government is constructing or planning to build 22 dams that will begin producing energy between 2015 and 2024, and an additional 16 dams are currently in the study phase (Ministério de Minas e Energia 2015). This article examines the case of one such project—the Belo Monte Hydroelectric Complex—which is under construction on the Xingu River in the Brazilian Amazon and will be the third largest dam in the world in installed capacity when completed in 2019. The government argues that Belo Monte is a crucial source of renewable energy needed to meet the country's rapidly growing energy demands. Yet the dam will have substantial social and environmental impacts, displacing 20,000 people including rural farmers, urban residents, and subsistence fishermen (Eletrobrás 2009).

In this article, I examine whether forced migration coupled with the infusion of capital from the compensation program served as an opportunity for rural farming households to make productive investments and undertake new livelihood strategies. I conceptualize compensation payments as a type of cash transfer that, similar to remittances or government conditional cash transfers, may support households in overcoming credit or capital constraints. Yet in contrast to remittances and conditional cash transfers—which often consist of multiple small payments received by households over the course of time—compensation payments are large, one-time transfers intended to cover the loss of a household's original land and livelihoods. In order to explore the link between compensation, displacement, and livelihoods, I use longitudinal household survey data from 165 households affected by the Belo Monte dam to ask (1) to what extent does compensation in the context of forced migration lead to livelihood diversification, and how are livelihood decisions affected by compensation amounts? and (2) does compensation enable households to make productive investments beyond replacement land and housing?

Background

Cash Transfers and Productive Investments

An important barrier to socioeconomic development among poor households in low- and middle-income countries is the lack of capital or credit to invest in assets, education, and income generating activities. One way that households circumvent this barrier is through cash transfers—both public and private—that can provide the capital necessary to make

these investments (Davis, Carletto, and Winters 2010). Private cash transfers are largely in the form of remittances, defined as money or assets sent to households by individuals who have migrated to other labor markets (Hoddinott 1994; Stark and Bloom 1985; Stark and Lucas 1988; Taylor 1999). Recipient households may invest remittances in a variety of ways, including in consumptive goods (e.g., food, housing, and household items), human capital (e.g., health and education), and productive assets (e.g., agricultural land and infrastructure and small businesses). Studies have found a variety of impacts of remittances, including increased investments in education, improved housing, higher household per-capita income, and greater investment in small businesses (Calero, Bedi, and Sparrow 2009; de Brauw and Rozelle 2008; Quisumbing and McNiven 2010; Taylor, Rozelle, and de Brauw 2003; Woodruff and Zenteno 2001). Yet remittances are not a catchall solution to capital or credit constraints among poor households, as not all households send migrants, not all migrants remit, and those who do remit do so to varying degrees.

Another way that households overcome capital constraints is through public cash transfer programs—policies implemented by governments in numerous low- and middle-income countries as a poverty alleviation strategy. A subset of these public transfers is conditional cash transfer (CCT) programs, in which households are provided with payments conditional on behaviors such as keeping their children in school or taking them to the doctor for regular checkups. CCT programs are prevalent in a number of Latin American countries, including Brazil and Mexico (Davis et al. 2010). Brazil's CCT program, Bolsa Família, is the world's largest and provides poor households with a monthly cash payment for each child aged 0–15 years (up to three children) conditional on pregnant women receiving prenatal care, each child aged 0–5 years receiving vaccines and health checkups, and each child aged 6–15 years attending school at least 85 percent of the time (de Brauw et al. 2015). In addition, the program offers unconditional transfers to extremely poor households below a per capita income threshold (Soares, Ribas, and Osório 2010). Researchers have found that Bolsa Família leads to positive outcomes for children, including increased school enrollments and reduced numbers of dropouts, better nutritional outcomes, and reduced childhood mortality (Amaral, Gonçalves, and Weiss 2014; Glewwe and Kassouf 2012; Paes-Sousa, Santos, and Miazaki 2011; Rasella et al. 2013). Research has also found that Bolsa Família increases adult labor force participation as well as household expenditures on food, education, and children's clothing (Soares et al. 2010). In addition, an analysis of Mexico's Oportunidades program found that poor rural households invested a portion of their transfers in productive assets, which led to a 10 percent increase in agricultural income after 18 months (Gertler, Martinez, and Rubio-Codina 2012).

Yet Lloyd-Sherlock, Saboia, and Ramírez-Rodríguez (2012) discovered that Bolsa Família led to very limited income benefits for households, averaging only US\$45 per month in 2008. In addition, public spending on the elderly, primarily through retirement payments, was found to be significantly higher than public spending on children through Bolsa Família (Turra, Holz, and Cotlear 2011). This finding is echoed in my data, as average Bolsa Família payments in 2014 were R\$188 per month (approximately US\$77) while retirement payments averaged R\$1,034 per month (approximately US\$422) (IRS 2015). Other criticisms of CCT programs like Brazil's are that they focus too strongly on building the human capital of children while neglecting adults, and that they do not foster the accumulation of productive

capital or assets (Hall 2008; Handa and Davis 2006). For example, Maluccio (2010) examined Nicaragua's CCT program, called Red de Protección Social, and found that the vast majority of money was being spent on food and education, while very little was used for economically productive investments. Thus, while CCT programs like Bolsa Família certainly contribute to household welfare, the small monthly payment amounts may be insufficient to enable households to make productive investments.

Displacement Compensation

Compensation payments for development-induced displacement can be viewed as a third type of cash transfer in addition to remittances and government cash transfers. Displacement compensation has in the past rarely enabled households to rebuild livelihoods, as it frequently has not reimbursed households for lost community resources and in many cases has not provided payments or land equivalent to the value of the land lost (Bartolome et al. 2000). Cernea (2003) pointed out that undercompensation may occur for many reasons, including failing to count all assets in compensation payments, subjectivity in valuing assets, delays in compensation payments, and appreciation in the value of assets that occurs after compensation amounts have been calculated. In addition, compensation rates are often below real market prices for land in the region (Mougeot 1990). For example, those displaced by the Kiambere Hydropower project in Kenya were compensated at a rate of KSh700 per hectare, though the market value for land in the area was KSh2,000 per hectare (Mburugu 1994). In order to achieve livelihood restoration, Cernea (1996) argues, displaced families must be compensated for assets at replacement cost as well as for lost income, and also must receive support for restarting lives in a new location.

Despite the findings that monetary compensation alone is not sufficient to prevent impoverishment after displacement (Cernea 1996, 2008; Downing 2002; Fernandes Serra 1993), Randell (2016) discovered that in the case of Belo Monte, monetary compensation enabled the majority of households to maintain or improve livelihoods in the first few years after migration. These findings suggest that if payments are large enough for households to replace lost property and assets at market value as well as invest in new assets, compensation may in fact enable households to improve their standards of living. In this article I examine whether and to what extent households utilized the compensation payments to invest in income-generating assets and pursue new livelihood strategies.

Income Diversification

A primary means through which households increase overall income or insure against income shocks is through income diversification. Ellis (1998:5) defined income diversification as "an active social process whereby households are observed to engage in increasingly intricate portfolios of activities over time." Income diversification may be motivated by "push" factors such as lack of credit and insurance or uncertain farming conditions, as well as "pull" factors such as the prospect of higher incomes in the nonfarm than the farm sector (Reardon, Berdegue, and Escobar 2001). Income diversification in rural areas is often achieved through rural nonfarm employment, which refers to employment outside agriculture, namely in manufacturing and service work (Reardon et al. 2001). In the 1990s, nonfarm income constituted 40 percent of rural incomes in Latin America (Reardon

et al. 2001), and studies have found evidence of high levels of nonfarm income diversification in rural areas of the Brazilian Amazon (Graziano da Silva and Del Grossi 2001; Steward 2007; VanWey and Vithayathil 2013).

Ellis (1998) noted that while studies of livelihood diversification tend to examine rural households, diversification is a relevant strategy in urban contexts as well. In Brazil, links between urban and rural areas have become stronger in recent decades (Graziano da Silva and Del Grossi 2001). Indeed, multisited households—in which households maintain both urban and rural properties or residences and often derive income from both locations—are common in the Amazon (Eloy, Brondizio, and Do Pateo 2015; Pinedo-Vasquez and Padoch 2009). In addition, a study in Chile found that paved roads made commuting between rural and urban areas easier, enabling rural households to sell products in nearby cities and urban households to undertake farm work in rural areas (Berdegué et al. 2001). This blurring of the rural-urban divide is evident in the Belo Monte study area as well. At baseline nearly all households had family members living in urban areas within the region, and a number of households owned houses in the city in addition to their rural properties.

Studies in Latin America have found that participation in rural nonag-ricultural income is linked to factors such as locational characteristics, education, social capital, wealth, and household composition (de Janvry and Sadoulet 2001; Jonasson and Helfand 2010; Perz 2005; VanWey and Vithayathil 2013). Reardon et al. (2001) noted that the relationship between wealth and nonagricultural income may function in two ways: Households with greater agricultural incomes may face less of a push to diversify, or conversely, they may have greater capital to invest in nonagricultural assets and therefore create a more diverse income portfolio. In rural Brazil, the amount of income received from nonagricultural sources rises with both household income and the amount of land owned (Reardon et al. 2001). This suggests that wealthier households are diversifying and earning more income from nonagricultural sources than are poorer households. For example, Barrett, Reardon, and Webb (2001) found that in an African context, wealthier households either earn income from agriculture or from nonagricultural businesses, while the poor are limited to diversifying into low-skilled off-farm or nonagricultural jobs. In Latin America as well, poorer households often cannot access higher paid non-farm employment, but instead tend to rely on low-productivity agriculture or low-pay agricultural wage labor (Reardon et al. 2001). Indeed, Reardon et al. (2001:401) argue, “when the lower income strata undertake multiactivity, they do it to survive, since they cannot prosper from these low-productivity dead-end jobs. Their participation in nonfarm jobs nonetheless keeps many from extreme poverty.” Thus, wealthier households are able to access the more lucrative nonfarm opportunities while poorer households are limited to low-wage work, whether within or outside agriculture.

Conceptual Approach

A number of studies have focused on rural livelihoods in low- and middle-income countries, as discussed above. Some have examined income diversification in light of social change and economic development, while others have studied how cash transfers are invested. Yet these issues have not been explicitly examined in the context of forced migration.

Understanding how displacement is linked to livelihood decisions and investments is key, as displacement necessarily entails a change in one's geographic, economic, social, and environmental context. As in the Belo Monte case, migrating as a consequence of development projects may offer households the opportunity to invest in new, more lucrative livelihood strategies that they may not have had the land or capital to pursue otherwise. Alternatively, development-induced displacement may threaten livelihoods by pushing households onto more marginal land and dissolving communities and social networks.

In order to examine changes in income sources, I first define four distinct categories of income. I adapt my definitions of income types from the three categories developed by Saith (1992): on-farm (income from livestock and crops), off-farm (income from wage labor on other farms), and nonfarm (nonfarm employment, self-employment, or rental income). I adjust this classification to the context of the Belo Monte study area, breaking nonfarm into two categories: nonfarm salaried or self-employment, and rental or business ownership.¹ Table 1 presents descriptions of the four categories.

On-farm income in the study area is often relatively lucrative, as households that own land can earn substantial income from the sale of cacao and cattle. On the other hand, off-farm agricultural wage labor is generally a less desirable source of income, as it indicates that either the household does not own land of its own or that the household cannot generate sufficient income from its land and therefore must supplement on-farm income with income earned from laboring on the farms of others. In the nonagricultural sector, households may earn income from salaried work or from the sale of products or services. The steady source of income—particularly among salaried employees—can act as an important supplement to overall household income. Lastly, households may earn income from renting out houses or apartments, or from owning a business. This income category—in particular renting out properties—is quite productive as it provides steady income and requires a low level of labor compared to farming activities.

Regarding forced migration, displacement may result in a few possible livelihood outcomes. First, households may reproduce their original income generation strategies after displacement, leading to no diversification overall. Second, households may expand into both agricultural and nonagricultural income sources, leading to a more diverse portfolio overall. Third, they may concentrate income generation efforts on the most lucrative sources (on-farm or nonagricultural), leading to lower levels of diversification overall. Given the high levels of income diversification in Brazil, the economic benefits of a diverse income portfolio, and the strong urban-rural linkages in the region, I expect that levels of income diversification will increase between baseline and follow-up. I also predict that wealthier households will be better able to diversify into the most lucrative forms of nonagricultural income, while poorer households will be more likely to continue relying on agricultural wage labor.

¹Remittances are also important sources of household income in many contexts. However, among the study households, remittances did not play an important role in household income. Only eight households at baseline and five at follow-up reported receiving remittances.

Lastly, I define productive investments as any investments made with compensation payments that directly contribute to future income generation. Agricultural land is one of the most important productive investments in this context. Additional productive investments may include investments in agriculture (e.g., constructing a corral for cattle, purchasing fertilizer, planting cacao trees, or clearing pasture), purchasing cattle, purchasing a house or apartment building to rent out, opening a store, or purchasing a tractor to perform services with. Investments in nonproductive assets include purchasing vehicles including motorcycles, cars, and pickup trucks, as well as purchasing a home in a nearby city for the household's own use.

Research Site and Study Population

The study area centers around the municipality of Vitória do Xingu, located in the eastern Amazon region in the state of Pará (see Figure 1). The region borders the banks of the Xingu River, one of the main tributaries of the Amazon River. The city of Altamira serves as the region's urban hub, with a population of approximately 100,000 (IBGE 2015). The region began to develop rapidly in the early 1970s with the government's National Integration Plan, which constructed highways through the rain forest, fostered colonization of the area by farmers, and promoted resource extraction and cattle ranching. The goal of the plan was to spur development in the interior of the country, alleviate landlessness and poverty in the drought-prone northeast region, and resettle squatters and smallholder farmers from southern Brazil (Alonso and Castro 2005; Browder and Godfrey 1990; Fearnside 1984; Ozório de Almeida and Campari 1995; Yoder and Fuguitt 1979). As part of the plan, the government constructed the Transamazon Highway, which runs through Vitória do Xingu as well as Altamira. These developments brought many of the study households to the region in the 1970s and 1980s, and led to a doubling of the population of Pará between 1970 and 1996, from 2.2 million to 5.5 million (Perz 2002). Now the region houses and processes a large herd of cattle and is home to the highest productivity cacao bean farms in the country (CEPLAC 2009). In 2010, the municipality of Vitória do Xingu produced nearly 170,000 head of cattle and R\$9 million in cacao beans (IBGE 2014).

The study population consists of rural farming households whose properties were expected to be completely or partially flooded to create the dam's primary reservoir as well as related infrastructure (see property boundaries in the bottom right map in Figure 1). Many of the households had lived in the area for decades, migrating to Vitória do Xingu from other regions of Brazil during the height of Amazon settlement in the 1970s and 1980s, while others moved to the region more recently. At baseline, community members ranged from landless sharecroppers to smallholder cacao farmers, to wealthy cattle ranchers. The households were compensated for their lost land and assets, and were then responsible for finding and purchasing new property on their own, without the formal assistance of a resettlement program.

The Belo Monte Dam

Norte Energia, a public-private partnership, is responsible for the construction and operation of the Belo Monte Dam. Plans for the dam began in 1975, but the process experienced long

delays due to concern over its environmental and social impacts, and was only granted a provisional license in 2010 (Hall and Branford 2012). Construction of the dam began in 2011 and is expected to be completed in 2019. Flooding of the area upstream from the main dam occurred in early 2016 when the first turbine began to run. According to the environmental and social impact assessment, the dam is projected to flood 516 square kilometers of land (Eletrobrás 2009). Official estimates predict that the dam will displace a little under 20,000 people—16,400 in urban Altamira and 2,800 living in rural surrounding regions including Vitória do Xingu (Eletrobrás 2009).

The Basic Environmental Plan (*Projeto Básico Ambiental*) (Norte Energia S.A. 2010) presents a detailed set of programs that must be implemented in order to mitigate the environmental and social impacts of Belo Monte. According to the plan, the rural displaced population has a choice of receiving monetary compensation for their land and assets, assisted relocation to a property in the same region that is at least equivalent in quality to the original property, resettlement assistance for rebuilding a home on the same property if it is partially flooded, or resettlement in a planned community for smallholder farmers or those without property rights. The rural resettlement program is intended to ensure that the housing conditions and income generation opportunities are equal to or better than those before construction of the dam (Eletrobrás 2009). Landowning households in this study population all received the first option—monetary compensation—and data suggest that this form of compensation was the only option offered to them at the time they were registered for the program. Compensation payments for landowning households were calculated based on the location of the property, replacement cost of houses and infrastructure on the property (irrespective of the condition of the original home), units of perennial crops (e.g., number of cacao or fruit trees), area of annual crops (e.g., hectares of corn, rice, or beans), and area of pasture including a depreciation factor based on the pasture's age and quality of maintenance (Norte Energia S.A. 2010). Those who did not own land (sharecroppers or those who lived on a relative's land) were provided with credit for approximately R \$132,000,² which they could use toward buying property with a definitive title or public deed. The amount of compensation received can therefore be used as a proxy for baseline wealth, as wealthier households tended to own more land and have more productive agricultural assets than poorer households, thereby receiving higher compensation amounts.

Methods

Data Collection

This article utilizes longitudinal household survey data from 165 households. The surveys were conducted with a subset of the rural population facing displacement (see original property boundaries in the bottom right map in Figure 1). The research team identified locations of households using maps of the affected area obtained from the dam's Environmental Impact Assessment (Eletrobrás et al. 2009) as well as data from Brazil's 2010 census. This included households of property owners as well as households of sharecroppers and of those living on the property of relatives. Approximately 200

²The 2012 Brazilian real—U.S. dollar exchange rate was approximately 2:1.

households were identified, and given the small size of the population, the project's goal was to survey a census of households in the geographic area in order to understand how displacement impacted all households.

Two Brazilian research assistants conducted baseline household surveys with 192 households in the study area in April and May 2012. They interviewed the male or female heads of household on topics including demographic and socioeconomic characteristics, income sources, property and asset ownership, and housing quality. At the end of the survey the interviewers asked for contact information (addresses and telephone numbers) of family or friends in order to obtain information on how to locate each household after displacement.

Using the contact information collected during the baseline survey as well as word of mouth, the research team obtained information on the postdisplacement locations of approximately 170 households. The households migrated throughout the region, primarily to rural properties without access to cellular or landline telephone service, which made identifying new residences challenging. Between August 2014 and January 2015, a team of local research assistants under my supervision conducted follow-up data collection activities. The data collection team was able to reinterview 165 of the 192 households, a follow-up rate of 86 percent. The displaced households migrated to 10 municipalities within the Transamazon region in Pará, as well as to the neighboring state of Maranhão (see Figure 1). The follow-up household surveys collected updated information on the same topics covered in the baseline surveys, along with additional questions specific to compensation and migration. Lastly, at baseline our research team expected that all 192 households would be compensated and displaced, yet 24 of the households reinterviewed did not receive compensation.³

Data Analysis

I explore how displaced households invested their compensation payments, as well as the factors associated with changing livelihood strategies after forced migration. I begin by examining income sources at baseline and follow-up, transitions between income sources, and the ways in which compensation payments were invested. I then estimate a set of binary logistic regression models to understand the factors associated with earning income from only on-farm production, any off-farm labor, and any rental properties or business ownership at follow-up.

Table 2 presents descriptive statistics for variables included in the models. One of the primary predictor variables is the amount of compensation received by the household. Twenty-four households received no compensation and 52 households who did not own land at baseline received a credit payment of approximately R\$132,000. Compensation payments ranged from R\$14,000 to R\$4.2 million, with a median payment of R\$390,000. I use a four-category variable to measure compensation: no compensation, up to the value of the credit payment, the bottom 50 percent of remaining households (R\$137,000–664,000), and the top 50 percent of remaining households (R\$669,000–4.2 million). Control variables include a set of baseline and follow-up household characteristics. Baseline wealth is measured by

³These households were not compensated either because the dam did not impact their land (19 households), because they were still expecting to receive compensation at the time of follow-up surveys (2 households), or for other reasons (3 households).

monthly household income in R\$ per month as well as land area owned in hectares. In addition, I control for the age of the household head. Follow-up characteristics include the number of household members, change in land area in hectares, and whether the household moved to an urban area.

Results

Investing Compensation Payments

Figure 2 presents data on how households invested their compensation payments. Ninety-six percent of households invested at least part of their compensation money in land or housing or both. Of the 141 compensated households, 80 percent bought rural land, 35 percent constructed a house, 21 percent bought a house in the city for their own use, 6 percent bought urban land, and 6 percent used the money to renovate their new home. In addition, many households invested in vehicles, an important asset in rural parts of the Transamazon region where road quality can be very poor and public transportation is extremely limited. Thirty-four percent of households purchased a car or pickup truck, while 26 percent purchased motorcycles. Vehicles enable households to more easily travel to Altamira or other cities to visit family, access services such as banks or hospitals, and transport agricultural products to buyers.

In addition, many households made productive investments beyond agricultural land that directly contribute to future income generation for the household. Thirty-nine percent invested in agricultural inputs or infrastructure for their farm; 35 percent bought cattle; 16 percent purchased a rental home or opened a business; and 3 percent purchased a truck, bulldozer, or tractor to perform services with. Further, 38 percent of households gave a portion of their compensation money to family or friends, 12 percent used money to pay off debts and loans, and 4 percent used a portion toward medical expenses.

Changing Income Sources

Table 1 presents income sources at baseline and follow-up. At the time of baseline surveys in 2012, well over half of households earned on-farm income. Among these households, 88 percent sold cacao, 67 percent sold cattle, and 36 percent sold other agricultural products as well including chickens, bananas, açai, or pigs. Nearly the same percentage of households earned income from off-farm work, much of which consisted of sharecropping, day laboring, or growing agricultural products on the land of relatives. Almost 20 percent of households had members engaged in nonfarm salaried work or self-employment including working as a teacher or bus driver or selling handicrafts, with a small percentage of households earning income from renting houses or owning a business.

Among households that remained in rural areas at follow-up, the vast majority earned on-farm income, over a quarter engaged in off-farm work, relatively few households engaged in nonfarm salaried work or self-employment, and over 10 percent earned rental or business income. Among rural households earning on-farm income, 56 percent sold cacao; 50 percent sold cattle; and 25 percent sold other products as well including chickens, pepper, bananas, or pigs. Among households that moved to urban areas, a third earned on-farm income,

almost 20 percent engaged in off-farm work, almost half earned non-farm salaried or self-employment income, and over a third earned income from business or rental properties.

Regarding income diversification, at baseline 21 percent of households incorporated nonagricultural income into their portfolio. Contrary to expectations, levels of income diversification did not increase between baseline and follow-up. At follow-up, only about a fifth of rural households and a quarter of urban households earned income from both agricultural and nonagricultural sources.

Figure 3 displays income transitions between baseline and follow-up for the 156 households that had members employed during both periods. The width of the arrows represents the relative number of households that transitioned from a given baseline category. At baseline, the category with the largest number of households was off-farm only, reflecting the lack of landownership among many households. Among those who earned only on-farm income at baseline, the majority either remained in the on-farm category only or incorporated rental or business income into their portfolio. For those that earned income from only off-farm work at baseline, the vast majority remained in the agricultural sector, and many transitioned to on-farm only income. By the time of follow-up interviews, the predominant income generation strategies had transitioned to on-farm only followed by incorporating business or rental income.

Taken together, the information presented in Table 1 and Figure 3 suggests little evidence of income diversification at the population level. The percentage of households engaging in both agricultural and nonagricultural income strategies remained fairly constant between baseline and follow-up. The lack of income diversification is particularly evident among households that remained in rural areas. Data for rural households suggest a pattern of income concentration, as many rural households transitioned out of off-farm labor and nonfarm work, concentrating on more lucrative on-farm income sources. In addition, households that relied solely on on-farm income increasingly focused on selling only cacao or cattle. Rural households that earned income from on-farm production only and sold a diversity of agricultural products (including bananas, pigs, and chickens, cacao, and cattle) decreased from 83 percent to 57 percent. Further, households relying on income solely from cattle production increased from none at baseline to over 20 percent at follow-up, and households relying on income from only cacao increased from slightly over 15 percent to over 20 percent.

Modeling Follow-up Income Sources

Table 3 presents results from a set of logistic regression models predicting the likelihood of engaging in three common follow-up livelihood strategies. The first model examines the factors predicting whether a household earns income from only the sale of agricultural products on land that it owns. Results indicate that households receiving the lowest compensation category as well as the highest compensation category were less likely to engage in only on-farm work. In addition, households that received no compensation were marginally less likely to engage in only on-farm work. Further, for every 10 hectares of land a household gained between baseline and follow-up, they were 5 percent more likely to

engage in only on-farm work. Lastly, households that moved to urban areas were significantly less likely to earn only on-farm income.

As mentioned above, participation in off-farm work generally signifies that the household does not possess its own agricultural land, or that members cannot earn sufficient income from their land and therefore must supplement it with day labor work. Ninety-two percent of households that earned income from off-farm work at follow-up had also done so at baseline, which indicates that while many households transitioned out of off-farm work, very few transitioned into it. The second model in Table 3 examines the factors associated with engaging in off-farm work at follow-up. Households that received no compensation were nearly seven times more likely to engage in off-farm work at follow-up than those that received between R\$137,000 and 664,000, and those that received between R\$14,000 and 132,000 were six times more likely to do so. Further, for each additional 10 hectares of land gained between baseline and follow-up, a household was 9 percent less likely to engage in off-farm work and households that moved to urban areas were less likely to engage in off-farm work at follow-up. In addition, households engaging in off-farm work were marginally more likely to own less land at baseline and live in larger households at follow-up.

In contrast to agricultural wage labor, income from business ownership or rental properties is often lucrative and rarely labor intensive. The third model in Table 3 predicts the likelihood of earning income from business or rental ownership at follow-up. While only 5 percent of households engaged in this form of income generation at baseline, 21 percent did so at follow-up (15 percent of rural households and 36 percent of urban households). Data indicate that households that were not compensated were 90 percent less likely to earn business or rental income than those that received between R\$137,000 and 664,000. In addition, those that earned between R\$14,000 and 132,000 were marginally less likely as well. Lastly, those who moved to urban areas were significantly more likely to own businesses or rental properties.

These findings suggest that households that received either no compensation or the lowest category of compensation were much less likely to transition out of agricultural wage labor and were less likely to own a business or rental property at follow-up. In contrast, those that received between R\$137,000 and 664,000 were the most likely to earn only on-farm income, while those that received the lowest and highest amounts of compensation were more likely to undertake other livelihood strategies. This provides evidence that compensation payments *did* in fact help households transition from less desirable income generation strategies to more desirable strategies, and that the ability to make this transition varied greatly based on the amount of compensation received.

Discussion and Conclusions

This article examines changes in income generation strategies among rural households displaced by the Belo Monte Dam, as well as the extent to which households invested their compensation payments in productive assets. In light of high rates of income diversification in rural regions of Latin America (Reardon et al. 2001), I study the livelihood decisions made by households forced to migrate. I find evidence for high levels of transitioning

between income generation strategies, but little evidence for diversification. The proportion of households earning income from both the agricultural and nonagricultural sectors remained constant between baseline and follow-up, at approximately 20 percent. As opposed to switching to more diverse income portfolios, many households (particularly those that remained in rural areas) transitioned toward portfolios that consisted of earning income solely from on-farm sources, or to a smaller degree from on-farm sources as well as business or rental income. I define this pattern as income concentration, as many households used compensation money to focus their income generation efforts on cacao or cattle production—both highly productive sources of income in the region.

I expected that households would utilize the compensation payments to diversify their income generation strategies given the high levels of income diversification in Brazil, the economic benefits of a diverse income portfolio, and the strong urban-rural linkages in the region, yet I did not find this to be the case. The study region's high cacao and cattle productivity make it somewhat unusual, as smallholder farming households can earn substantial income from the sale of these products. Given the high income potential from agriculture in the area, many households made the decision to concentrate efforts on cacao or cattle instead of engaging in a multiplicity of income generation strategies. This decision illustrates that households used their compensation money strategically, investing in the most lucrative options given the regional economic and environmental context in which they were operating.

In addition, a number of households were able to transition out of off-farm work, a less desirable income source associated with not owning land or with needing to supplement household income with additional day labor work. The percentage of households with members engaging in agricultural wage labor decreased from 59 percent at baseline to 25 percent at follow-up. Households with members who remained engaged in agricultural wage labor at follow-up were more likely to be poorer, and to have received either no compensation or low amounts of compensation. In contrast, owning a business or renting out houses is a desirable, steady source of income that requires little day-to-day physical labor (as opposed to agricultural work). The percentage of households that engaged in rental or business income increased from 5 percent at baseline to 21 percent at follow-up (15 percent of rural households and 36 percent of urban households). Eighty percent of households that engaged in business or rental strategies at follow-up had earned on-farm income at baseline, and results from the regression analysis indicate that these households were more likely to have received higher amounts of compensation.

Taken together, these results suggest that many households were able to utilize the compensation money to concentrate income generation efforts on the most lucrative and desirable strategies—cacao and cattle production and business or rental income. In contrast, poorer households as well as those that received low amounts of compensation were more likely to continue relying on agricultural wage labor. These findings echo a study in rural Africa by Barrett et al. (2001), which discovered that wealthier households earned income from agriculture or businesses while poorer households were restricted to low-skilled agricultural wage labor or nonagricultural jobs. In addition, a study in Latin America by Reardon et al. (2001) found that poor households were often limited to low-productivity

agriculture or agricultural wage labor. In this study, wealthier households were able to transition toward the more lucrative income options within the region, while poorer households, as well as those that received no compensation or credit payments, did not have the resources to do so.

Yet having a diverse income portfolio does serve an important role in protecting households against local shocks to the labor market or environment. Therefore, while income concentration entails a focus on the most productive strategies, it may leave households vulnerable to income shocks. For example, households that rely exclusively or primarily on cattle could experience significant economic losses in the event of an outbreak of foot-and-mouth disease, or a household that relies exclusively on income from rental houses in Altamira may suffer economic losses once dam construction ends. Belo Monte led to large-scale in-migration into Altamira as migrants took advantage of the thousands of direct or indirect employment opportunities related to dam construction (Hall and Branford 2012). This population growth has increased demand for housing, yet once construction ends in 2019 many of these migrants are likely to leave Altamira in search of new economic opportunities. This could lead to an overabundance of available rental housing, and in turn to income losses for the households that rely on rental income for their livelihoods.

Another issue relevant in the Transamazon region of Brazil is the growing link between urban and rural areas—a blurring of the rural-urban divide (Graziano da Silva and Del Grossi 2001). I find that among the households that remained in rural areas, 13 percent earned income from nonagricultural work in urban areas or from urban rental properties, and among households that moved to cities, 33 percent incorporated on-farm income from rural land they owned. Most of these households invested in both rural and urban properties and derived income from both locations, which supports the concept of multisited households in the Amazon (Eloy et al. 2015; Pinedo-Vasquez and Padoch 2009). The ability of households to obtain income from both rural and urban areas is due in part to compensation payments that were sufficient to enable them to purchase property in both areas. In addition, the improving road quality in the region eases travel between rural areas and the nearby cities (Berdegue et al. 2001), and many households had friend and family networks that extended to urban areas, which provided key resources for finding urban properties or employment.

The ability of households to transition toward more productive income generation strategies, and therefore to improve their living standards, is limited by the amount of capital that they have available to invest in productive assets. Results indicate that the level of compensation was sufficient for the majority of households to make productive investments beyond attaining replacement land and housing. These households invested in assets such as agricultural infrastructure, cattle, rental houses, or tractors—all of which directly contribute to income generation. Displacement compensation, like remittances or conditional cash transfers, can therefore act as an important infusion of capital that promotes socioeconomic development and poverty reduction.

This study provides evidence that resettlement programs based on compensation can be effective, as rural farming households in the Belo Monte case were by and large able to manage their compensation money well and make beneficial investments that enabled them

to improve livelihoods. Compensation payments must cover the cost of purchasing replacement land and housing in the region, and must provide additional funds so that households can make productive investments.

Lastly, this study shows that providing agricultural households with a large, one-time cash transfer can lead to productive investments, and in turn, to poverty alleviation. While Brazil's conditional cash transfer program Bolsa Família has been shown to contribute to positive health and schooling outcomes for children (Amaral et al. 2014; Glewwe and Kassouf 2012; Paes-Sousa et al. 2011; Rasella et al. 2013), the small monthly payments that characterize CCT programs have been criticized for not being sufficient to enable households to invest in productive assets and in turn to improve living standards (Hall 2008; Handa and Davis 2006). Among the 40 households in my study that received Bolsa Família payments at the time of follow-up surveys, the mean monthly payment was R\$188 (approximately US\$77). This was substantially lower than the monthly food expenditure for these households, which averaged R\$462 (approximately US\$231). The results from my analysis suggest that perhaps providing households with a large lump sum cash transfer, as opposed to small monthly payments, may be more effective in facilitating productive investments, which can in turn enable them to improve their socioeconomic conditions. This could be tested in the future through a randomized study that provides some households with monthly payments akin to current Bolsa Família payments and others with lump sum payments in varying amounts. This would allow researchers to determine whether larger, one-time payments are more effective at poverty reduction and whether there exists a threshold for the amount of payment needed to make productive livelihood investments.

In sum, the examination of income diversification and productive investments among households affected by the construction of the Belo Monte Dam provides a lens through which to see how households rebuild livelihoods, how they make decisions when provided with an infusion of capital, and how the amount of capital provided affects the ability of households to improve their standards of living. A cash-based compensation program—provided that it is sufficiently funded—can therefore be viewed as a highly effective model for restoring livelihoods after development-induced forced migration.

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Figure 1.
Study area in Brazilian Amazon including baseline property boundaries and approximate migration destinations.

Figure 2.
Households' investments of compensation payments.

Figure 3.

Income source transitions between baseline and follow-up surveys. [Color figure can be viewed at wileyonlinelibrary.com]

Table 1
 Descriptions of Income Generation Strategies and Proportion of Households Undertaking Each Strategy Baseline and Follow-up.

Sector	Category	Definition	Examples	2014–15		
				2012	Rural	Urban
Agriculture	On-farm	Sale of agricultural products from property owned by the household	Sells cacao, cattle, chickens, pigs, fruit; rents out pasture	0.60	0.84	0.33
	Off-farm	Agricultural wage income, sale of agricultural products from property not owned by the household	Sharecropper, day laborer, cowherd; sells products grown on a relative's land	0.59	0.28	0.17
Nonagriculture	Nonfarm salaried or self-employment	Public- or private-sector salaried work, sale of products or services	Teacher, bus driver; sells handicrafts, fish, or gasoline; performs freight work with tractor	0.18	0.05	0.43
	Rental or business	Income from business ownership or rental property	Rents out house; owns market or clothing store	0.05	0.15	0.36
Number of households				165	123	42

Note: At the time of follow-up surveys, members of 17 percent of urban households and 2 percent of rural households were not employed.

Table 2

Descriptive Statistics of Study Households.

	Mean/Proportion	Standard Deviation	Minimum	Maximum
Compensation				
No compensation	0.14		0	1
R\$14,000–132,000	0.32		0	1
R\$137,000–664,000	0.27		0	1
R\$666,000–4.2 million	0.27		0	1
Baseline characteristics				
Monthly household income (R\$)	2,261.44	2,579.36	152	23,908
Land area (ha)	88.02	165.45	0	1,517
Age of household head	46.37	14.12	20	80
Follow-up characteristics				
Household size	3.56	1.74	1	9
Change in land area (ha)	57.66	235.07	–300	2,626
Household lives in an urban area	0.26		0	1
Number of households	163			

Note: Excludes two households with missing baseline income data.

Table 3

Odds Ratios from Logit Models Predicting the Likelihood of Engaging in Different Income Generation Strategies at Follow-up.

	On-Farm Income Only	Any Off-Farm Income	Any Business or Rental Income
Compensation (baseline = R\$137,000–664,000)			
No compensation	0.28 ⁺	6.77 ^{**}	0.10 [*]
R\$14,000–132,000	0.26 [*]	5.97 ^{**}	0.29 ⁺
R\$666,000–4.2 million	0.24 [*]	0.40	1.07
Baseline characteristics			
Natural log of monthly household income	1.33	0.64	1.60
Land area (ha)	1.00	0.99 ⁺	1.00
Age of household head	0.98	0.99	1.01
Follow-up characteristics			
Household size	1.05	1.23 ⁺	1.00
Change in land area (10 ha)	1.05 [*]	0.91 [*]	0.99
Household lives in an urban area	0.06 ^{***}	0.21 [*]	4.42 ^{**}
Constant	0.41	6.62	0.00 ⁺
Pseudo R ²	0.25	0.30	0.19
Likelihood ratio chi ²	54.69	54.22	29.17
Probability > chi ²	0.00	0.00	0.00
Number of households	163	163	163

Note: Excludes two households with missing baseline income data.

⁺ $p < .1$;

^{*} $p < .05$;

^{**} $p < .01$;

^{***} $p < .001$