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The short-term impacts of development-induced displacement on wealth and subjective well-being in the Brazilian Amazon

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Summary

Displacement due to development projects such as dams, mines, and urban infrastructure often leads to livelihood decline among affected communities. The challenge, therefore, lies in implementing projects that achieve national or regional development goals while also generating positive social and economic outcomes for displaced populations. This paper uses a longitudinal, mixed-methods design to understand the short-term changes in wealth and subjective well-being of households displaced due to construction of the Belo Monte Dam in the Brazilian Amazon. The households were compensated by either cash or credit for their lost land and assets, and were then responsible for finding and purchasing new property. Using pre- and post-displacement household survey and semi-structured interview data, as well as data from a small comparison group, I find that wealth increased for the majority of the study population and that socioeconomic inequality decreased, as poorer households experienced greater improvements in housing conditions, assets, and property ownership. In addition, subjective well-being improved for most households, particularly among those who did not own land at baseline, those who gained assets such as vehicles, those who remained closer to the original study area, and those who remained in close proximity to other households from the study population. Moving to an urban destination was strongly associated with declines in well-being, as was moving far from family or friends. These results suggest that investing sufficient resources in a compensation-based resettlement program can benefit households displaced by large infrastructure projects in the short term, but additional data collection is needed after the completion of dam construction to determine whether these benefits are sustained over the longer term.

Keywords

development-induced displacement; subjective well-being; Brazil; hydroelectric dams; wealth; inequality

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1. INTRODUCTION

Development projects such as mines, hydroelectric dams, and urban infrastructure have important implications for local communities that can range from new employment opportunities and improved public services to environmental degradation, poverty, and displacement. Displacement is a significant element of development projects, as an estimated 15 million people per year worldwide are forced from their homes to make way for infrastructure construction (Cernea & Mathur, 2008). Most cases of development-induced displacement have resulted in socioeconomic decline for the displaced population, as relocated communities face the task of restoring livelihoods amid new—and often less favorable—geographic, environmental, social, and economic conditions (Cernea, 2008; Scudder, 2005). Yet cases of successful resettlement illustrate that displacement and socioeconomic decline need not go hand in hand (Cernea & McDowell, 2000; Mejia, 2000; Partridge, 1993; Picciotto, Van Wicklin, & Rice, 2001). The challenge, therefore, lies in implementing projects that achieve national or regional development goals while also generating positive social and economic outcomes for displaced populations.

Dams are a major contributor to development-induced displacement, and in Brazil alone, their construction has flooded 3.4 million ha of productive land and displaced more than 1 million people (Zhou & Oliveira, 2007). Brazil has a long history of implementing development projects in the Amazon region, including hydroelectric dams, mines, and highways. While many of these projects achieved national-level objectives centered on utilizing the region's natural resource potential, numerous studies have documented their negative impacts on local populations including smallholder farmers, fishermen, indigenous communities, and displaced households (e.g., Fearnside, 1999; Hall, 1989; Moran, 1981; Roberts, 1995; Smith, 1982). Yet despite the often adverse effects on local populations and ecosystems, dam building continues in Brazil at a rapid pace (Fearnside, 2016). The Brazilian government is constructing or planning to build 22 dams that will begin producing energy during 2015–24, and an additional 16 dams are currently in the study phase (Ministerio de Minas e Energia, 2015).

This paper uses a longitudinal, mixed-methods design to understand the short-term changes in wealth, socioeconomic inequality, and subjective well-being among households displaced due to construction of the Belo Monte Dam in the Brazilian Amazon. Belo Monte will be the third largest dam in the world in installed capacity when complete in 2019, and the Brazilian government argues that it is a crucial source of renewable energy needed to meet the country's rapidly growing energy demands. The dam will lead to substantial social and environmental impacts including altering the flow of the Xingu River, threatening fish populations, and displacing 20,000–40,000 rural farmers, urban residents, and subsistence fishermen (Eletrobrás, 2009; Paine de Especialistas, 2009). This paper focuses on a rural population of cacao farmers, sharecroppers, and cattle ranchers whose homes and land have been flooded to create the dam's main reservoir and associated infrastructure. The households were compensated by either cash or credit for their lost land and assets, and were then responsible for finding and purchasing new property without the formal assistance of a resettlement program. The stated goal of the dam's compensation program was to improve the living conditions of the population above predisplacement levels, with a particular goal

of transitioning landless households into landowners in accordance with the Brazilian government's model of "land for people, for people without land" (Norte Energia, 2010, 2012).

In light of the compensation program's goals, I address two main questions in this paper: (1) How does Belo Monte's compensation program affect wealth, inequality, and subjective well-being in the first few years after displacement? and (2) What factors are associated with household-level changes in wealth and subjective well-being? Results indicate that wealth increased for the majority of the study population and that socioeconomic inequality decreased, as poorer households experienced greater improvements in housing conditions, assets, and property ownership. Subjective well-being also improved for most households, particularly among households who did not own land at baseline, those who gained assets such as vehicles, those who remained closer to the original study area, or those who remained in close proximity to other households from the study population. Moving to an urban destination was strongly associated with declines in well-being, as was moving far from family or friends. These results suggest that investing sufficient resources in a compensation-based resettlement program can benefit households displaced by large infrastructure projects. Additional rounds of data collection after the completion of dam construction are needed to determine whether these benefits are sustained over the longer term.

2. BACKGROUND

(a) Development-induced displacement

Development-induced displacement is characterized by the permanent relocation of all households within a geographic area as a result of the construction of infrastructure projects, including large dams. In their seminal report, the World Commission on Dams (2000) argued that "the end of any dam project must be the sustainable improvement of human welfare" (p. 2), yet the majority of past research on dam-induced displacement has found evidence of socioeconomic decline among affected populations. In a meta-analysis of 44 communities displaced by the construction of large dams, Scudder (2005) found that in 82% of cases, displacement worsened living standards for the majority of the population.¹ For example, the Kiambere Hydropower project in Kenya led to a drop in average landholdings from 13 to 6 ha and to an 89% drop in household agricultural income among those displaced (Mburugu, 1994). Additionally, communities displaced by the Three Gorges Dam in China experienced significant losses in the amount and quality of farmland, reductions in household income, increases in debt, poorer health, less social support, and greater levels of absolute poverty (Hwang, Cao, & Xi, 2011; Wilmsen, Webber, & Duan, 2011). Numerous past dams in Brazil have been criticized for their adverse impacts on local communities, including the Tucuruí Dam, built in the 1980s in the Amazon. Tucuruí displaced 30,000 people, many of whom received no compensation. In addition, affected communities experienced negative social, economic, and health impacts including mosquito-borne disease

¹The dams were constructed during 1950s–90s, and most were located in Asia, Africa and the Middle East, and Central and South America.

outbreaks, poverty, and land abandonment (Fearnside, 1999; LaRovere & Medes, 2000; Monosowski, 1990).

Yet examples of successful relocation programs do exist. Partridge (1993) examined the case of the Arenal Hydroelectric Project in Costa Rica, which resulted in positive socioeconomic outcomes due to thorough planning, the use of anthropological research to inform the program, involvement of the affected community in the planning process, and the gradual introduction of new agricultural technologies to resettled farmers. Mejia (2000) discussed resettlement due to the Yacyretá Hydroelectric Project in Argentina. A comprehensive economic recovery plan was implemented that allowed community members to either continue their traditional economic activities or choose new, alternative livelihood options. As a result, many families were able to make economic decisions that best suited them, and in turn, avoid impoverishment. Further, two hydroelectric projects in China—the Shuikou and Yantan Dams—resulted in better living conditions after displacement, which can be attributed to extensive participation in relocation planning by local governments, close involvement of families in resettlement decision-making, high expenditures for each household, and proactive government programs to create jobs and improve incomes (Cernea, 1996; Picciotto *et al.*, 2001; Zhu, ter Woort, & Trembath, 2000). These cases illustrate that, while the exception rather than the norm, it is possible for well-implemented resettlement programs to result in improved livelihoods.

Displaced households are often compensated for their move by money and/or replacement land. Among rural agricultural communities, replacement land has generally been viewed as the most appropriate compensation strategy in order to avoid complications associated with land speculation and price inflation (Koenig, 2006; Lassailly-Jacob, 1996). In addition, a World Commission on Dams report found that monetary compensation is rarely adequate, as it does not reimburse for lost community resources and often does not provide payments equivalent to the value of the land lost (Bartolome, Wet, Mander, & Nagaraj, 2000). Under-compensation may occur for many reasons including failing to count all assets, delays in payments, and an appreciation in the value of assets after compensation amounts have been determined (Cernea, 2003; McCully, 2001; World Commission on Dams, 2000). Indeed, Cernea (1997) states, “what is needed...is a change in concept and method predicated on treating resettlement operations as opportunities for development, as development projects in their own right...one essential implication of this approach must be spelled out clearly: the cost of reestablishing a family and a community is generally bound to exceed the strict market value of the physical losses imposed on that family or community. Compensation alone, by definition, is therefore never sufficient for reestablishing a sustainable socioeconomic basis for resettlers” (p. 1579). This paper examines whether a compensation-based resettlement program *can* lead to improved socioeconomic conditions among displaced households.

In order to measure the impacts of development-induced displacement, an ideal research design would collect both pre- and post-displacement data from displaced households as well as from a similar control group who was not affected—directly or indirectly—by the development project. This research design is challenging to implement given the costly and time intensive nature of longitudinal data collection and difficulty locating households after

displacement. In addition, it is difficult to identify an appropriate control group, as development projects often affect non-displaced households in the region indirectly by altering economic and environmental conditions. Thus, it is challenging to isolate these impacts from those caused directly by displacement.

As such, few quantitative longitudinal studies of development-induced displacement exist. Most longitudinal research has used ethnographic methods to understand how displacement alters kinship systems, social structure, and livelihoods (Colson, 1971; Fahim, 1981; Jing, 1996; Mejia, 2000; Salisbury, 1986; Scudder, 1993). Non-longitudinal quantitative studies have employed post-resettlement cross-sectional methods by either comparing socioeconomic characteristics of resettled communities to those who were not resettled (Galipeau, Ingman, & Tilt, 2013; Mburugu, 1994) or by surveying resettled households retrospectively about their pre- and post-displacement socioeconomic conditions (LaRovere & Medes, 2000; Partridge, 1993; Wilmsen *et al.*, 2011). The lack of pre-displacement data in these studies makes them vulnerable to recall and selection bias. Other studies have collected pre- and post-displacement quantitative data from resettled households but lack data from a control group (Zhu *et al.*, 2000). One of the few existing comparative longitudinal studies used a quasi-experimental design to examine the impacts of the Three Gorges Dam by collecting baseline and follow-up survey data from displaced households as well as households from the same communities who were not required to relocate (Hwang *et al.*, 2011; Xi, Hwang, & Drentea, 2013). Similarly, I approximate the ideal study design by collecting pre- and post-displacement quantitative data from the displaced population as well as from a small comparison group that lived in the original study area at baseline but did not receive compensation. In addition, I add to this design by incorporating qualitative semi-structured interview data to more deeply explore the quantitative findings.

(b) The socioeconomic determinants of subjective well-being

In seeking to understand the impacts of a livelihood shock such as displacement, it is crucial to take a multidimensional approach that incorporates both economic and non-monetary measures. One such non-monetary measure is subjective well-being, which Diener (2006) defines as “the different valuations people make regarding their lives, the events happening to them, their bodies and minds, and the circumstances in which they live” (p. 153). Indeed, Helliwell and Putnam (2004) argue that subjective well-being should be “the ultimate ‘dependent variable’ in social science”, as this measure enables people to assess their quality of life in a holistic manner (p. 1435). This study joins a line of research on the link between mobility and subjective well-being, including work on refugees (e.g., Correa-Velez, Gifford, & Barnett, 2010; Fozdar & Torezani, 2008; Van Tran, 1987) and economic migrants (e.g., Cuellar, Bastida, & Braccio, 2004; Knight & Gunatilaka, 2010; Nowok, Van Ham, Findlay, & Gayle, 2013). Migration—whether driven by economic opportunities, political instability, or development projects—alters social networks, income, livelihoods, and living conditions. The change in migrants’ conditions before and after moving is linked in fundamental ways to their perceptions of well-being and life satisfaction. I extend this body of research in order to understand the factors that drive the relationship between mobility and well-being in the context of development-induced displacement.

A number of studies have examined the links between social capital and subjective well-being (e.g., Cramm, Møller, & Nieboer, 2012; Helliwell & Putnam, 2004; Yamaoka, 2008; Yip *et al.*, 2007). Helliwell and Putnam (2004) found that the frequency of interaction with friends and neighbors was positively associated with well-being, and Yip *et al.* (2007) discovered that in rural China, trust, reciprocity, and a sense of belonging were all associated with greater well-being. In addition, studies have examined economic correlates with subjective well-being. Some argued that absolute income is associated with perceptions of well-being (e.g., Diener, Sandvik, Seidlitz, & Diener, 1993; Sacks, Stevenson, & Wolfers, 2010) while others supported a relative income approach, as people assess well-being based on their economic position in relation to others around them (e.g., Easterlin, 1995; Knight, Lina, & Gunatilaka, 2009). Further, Helliwell and Putnam (2004) found that happiness increases with income but with diminishing returns, stating that “for the relatively poor, money can buy happiness, but for the relatively well-off, more money does not typically mean more happiness” (p. 1440).

Lastly, Knight and Gunatilaka (2010) found that rural-to-urban migrants in China had lower subjective well-being than either individuals that remained in rural areas or urban-born individuals. They attributed this finding to three plausible explanations: that migrants had expectations about life in the city that were not fulfilled, that they had relatively low income compared to urban-born residents, or that less happy people were selected into migration. Taken together, the literature on subjective well-being would suggest that rural households displaced by Belo Monte will experience higher well-being if they are able to maintain social networks and communities, were poorer at baseline and achieve absolute and/or relative economic gains, and remain in rural areas.

3. THE STUDY AREA AND DAM

Figure 1 shows the study area, which lies in the eastern Amazon region of Brazil in the state of Pará. The region began to develop rapidly in the early 1970s with the government’s National Integration Plan (PIN), which constructed highways through the rainforest, promoted colonization of the area by farmers, and fostered resource extraction and cattle ranching. The goal of the colonization projects was to develop 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 & Castro, 2005; Browder & Godfrey, 1990; Fearnside, 1984; Ozório de Almeida & Campari, 1995; Yoder & Fuguitt, 1979). As part of the plan, the government constructed the Transamazon Highway, which runs through Vitória do Xingu as well as the nearby city of 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 during 1970–96, 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 (Comissão Executiva do Plano da Lavoura Cacaueira, 2009). Altamira serves as the region’s urban core, with a population of approximately 100,000 (IBGE, 2015).

Norte Energia, a public–private partnership, is constructing the Belo Monte Hydroelectric Complex. Plans for the dam began in the 1970s, but the process experienced long delays due

to concern over its environmental and social impacts. The project was redesigned a number of times to reduce potential impacts, and was pushed forward in the 2000s under then President Luiz Inácio Lula da Silva as part of a national program to foster economic growth (Fearnside, 2006). Construction began in 2011 and will continue until 2019. The area upstream from the dam was flooded in early 2016 when the first turbine began operating. According to the environmental and social impact assessment, the dam is expected to flood 516 km² of land and displace approximately 20,000 people—16,400 in urban Altamira and 2,800 living in rural surrounding regions (Eletrobrás, 2009), though a panel of experts predicted that the actual number displaced could be up to 40,000 (Painel de Especialistas, 2009).

The Basic Environmental Plan (*Plano Básico Ambiental*—PBA) (Norte Energia, 2010) is a mitigation plan for the dam's social and environmental impacts, and indicates that the rural displaced population has a choice of: (1) monetary compensation for their land and assets (the choice of the majority); (2) assisted relocation to a property in the same region; (3) resettlement assistance for rebuilding a home on the same property if it is partially flooded; or (4) resettlement in a planned community in the region for smallholder farmers or those without property rights. According to the PBA, compensation payments for landowning households were calculated based on the location of the property, replacement cost of new 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, 2010). Those who did not own land (sharecroppers or households that 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.

In addition to household-level compensation, Norte Energia is investing R\$200 million per year in the city of Altamira as well as eleven nearby municipalities with the goal of fostering regional development (Norte Energia, 2011). This includes the construction of schools, health centers, sanitation projects, and power grids. Moreover, Norte Energia contends that the dam is bringing 20,000 direct jobs and 40,000 indirect jobs to the region (Norte Energia, 2011). It is important to note that investment and economic opportunities in the region vary greatly based on the stage of dam construction and operation. Investment is high during construction, leading to jobs, immigration, and increased property values (Hall & Branford, 2012). Yet once construction of the dam is complete in 2019, many of the employment opportunities directly related to construction activities will end, which may lead to large-scale out migration and to an economic downturn in Altamira and the surrounding areas.

4. METHODS

(a) Data collection

This paper uses a mixed-methods, longitudinal data collection strategy to understand the short-term socioeconomic and well-being outcomes of Belo Monte's associated cash-based

²The 2012 Brazilian Real—US Dollar exchange rate was approximately 2:1.

resettlement program. Combining quantitative and qualitative methods provides for a contextual, nuanced, and comprehensive understanding of social phenomena (Axinn & Pearce, 2006; Camfield, Crivello, & Woodhead, 2009; Knodel, 1997). I utilized a triangulation design, collecting quantitative and qualitative data simultaneously, which allowed me to compare the two types of findings and to expand on the statistical findings with qualitative data (Creswell & Clark, 2007). Household survey data were collected during two time periods: pre-displacement (April and May 2012) and post-displacement (August 2014 to January 2015) and semi-structured interview data were collected from a purposive subset of the survey population during the same two time periods. The goal of the research was to survey all households living within the boundaries of one of the main rural areas to be flooded (see lower right map in Figure 1). The locations of households were identified using maps of the affected area that were obtained from the dam's Environmental Impact Assessment (Eletróbrás *et al.*, 2009) as well as data from the 2010 Census. This included households of property owners as well as households of sharecroppers and those living on the property of relatives.

(i) Household surveys—In April and May 2012, two Brazilian research assistants located approximately 200 households in the study area and succeeded in surveying 192 households, consisting of 676 individuals. Surveys were conducted with the male and/or female head of household and the questionnaire focused on topics including property and asset ownership; housing quality; household income; household composition; and demographic and socioeconomic characteristics. At the end of the survey, the interviewer asked for contact information (addresses and/or telephone numbers) for the household and family or friends in order to obtain information on how to locate each household after displacement.

Using this contact information collected during the baseline survey as well as word of mouth, information was obtained on the post-displacement locations of approximately 170 households. The households migrated across the region, primarily to rural properties without access to cellular or landline service, which made identifying new residences challenging. The majority of households moved between July 2012 and January 2013,³ and between August 2014 and January 2015 follow-up data collection activities were conducted. The data collection team was able to re-interview 165 of the 192 households, a follow-up rate of 86%. The 165 households consisted of 587 individuals. Twenty-six households were lost to follow-up while one household, a single elderly man, was lost due to his death.⁴ The displaced households migrated throughout the Transamazon region in Pará, as well as to the

³While most households migrated between mid-2012 and early-2013, some moved as early as January 2012 and as late as June 2014. As such, for the majority of households, follow-up data were collected between 1.5 and 2 years after displacement.

⁴Of the 26 households lost to follow-up, five were sharecroppers who were not compensated but left their jobs without providing updated contact information, nine were households for which we could not obtain any information on their new locations, two were not home when we attempted to interview them, three moved after their initial move and neighbors did not know their new contact information, six were households with inaccurate information on the location of their new homes, and one was in prison during the time of follow-up data collection. The 26 households were younger on average than the households we followed up with, and were more likely to have been landless and without electricity at baseline. The households were poorer and less connected to others in the study community, which means that they may have experienced more negative impacts of the dam than the households successfully re-interviewed, potentially upwardly biasing the results.

neighboring state of Maranhão (see Figure 1). GPS data on the new household location were collected for 141 of the 165 households.

At baseline it was expected that all 192 households would be compensated and displaced, yet 24 of the households re-interviewed received no compensation, either because the dam did not flood 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). Half of the 24 households remained on their original properties, while the other half moved to new locations. These households serve as a small intent-to-treat comparison group, allowing me to compare wealth and well-being changes between compensated households and households who remained in the region but did not receive compensation. In addition, four households received compensation for part of their land, but were able to remain on their original property. Thus, a total of 16 households did not move from their property between baseline and follow-up.

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. The survey ended with a question on change in subjective well-being—whether the respondents believed that their lives had gotten much better, better, stayed the same, gotten worse, or much worse since being affected by the dam. The survey then asked an open-ended question in order for the respondents to explain why their lives had improved, stayed the same, or worsened.

(ii) Semi-structured interviews—In August 2012, a Brazilian research assistant and I conducted pre-displacement semi-structured interviews with male and/or female heads of 28 households from the study area, a subset of the households surveyed. The research assistant had conducted the baseline household surveys a few months prior, so he had established a rapport with the study households, which proved critical for obtaining high quality data. The households were purposively sampled from the survey population in order to capture maximum variation along a number of factors, including the amount of land owned, length of time living in the study area, and household income.⁵ Furthermore, households were chosen based on their willingness to participate. In addition to these 28 households, we interviewed 11 households who had already migrated to new homes in the region to explore processes surrounding differences in the timing of displacement. For these 11 households, I obtained information on their locations using a snowball sampling methodology. I asked others in the interview sample to identify households who had already migrated, and when interviewing these “early mover” households I then asked them to identify other early movers with whom we could conduct interviews.⁶

Interviews averaged 30–60 min in length, and questions followed an interview guide that focused on topics including the household’s history, community, and livelihoods in the study

⁵Baseline median land ownership was 45 ha (ranging from 0 to 600 ha); median total monthly household income was R\$1,704 (ranging from R \$494 to R\$11,008); and the median year the household head migrated to the study area was 1981 (ranging from 1952 to 2003). Five of the household heads were born in the study area.

⁶Seven of the early mover households had migrated prior to the time that baseline household surveys were implemented. For these households we conducted surveys at the same time as the interviews. The data collected in the household survey referred to their pre-migration conditions.

area; the compensation process; migration aspirations and plans (asked to the households who had not yet moved); and the moving process and reasons for choosing migration destinations (asked to the early mover households). Interviews were recorded with informed verbal consent from the interviewees and transcribed by a native Portuguese speaker. Excerpts were selected and translated into English only after coding was complete to protect the integrity of the data. Ethics approval was granted by Brown University's Institutional Review Board.

Then, between August and October 2014, a Brazilian research assistant and I conducted post-displacement semi-structured interviews with the 28 households who had not yet moved at baseline. I located and re-interviewed all 28 households, including the one household that moved outside Pará to the neighboring state of Maranhão. Post-displacement interviews followed an interview guide that focused on three main substantive areas: negotiating and receiving compensation, finding and moving to new properties, and reestablishing livelihoods and social networks in their new communities. For this analysis, these 28 interviews were combined with the 11 interviews from the "early mover" households, for a total of 39 post-displacement interviews.

(b) Creating the wealth index

One of the primary outcome variables in this analysis is the change in wealth between the two survey rounds. In order to create a measure of wealth at baseline and follow-up, I constructed an wealth index using polychoric principal component analysis (PCA) based on Filmer and Pritchett (2001) and Vyas and Kumaranayake (2006).⁷ I chose to focus on wealth instead of income, as many households rely on in-kind transfers of food and services, and farming households often sell their crops or livestock intermittently during the year, making it difficult for them to estimate an accurate monthly income (Kolenikov & Angeles, 2009; Moser & Felton, 2007). Further, this study follows up with households shortly after displacement. A number of households were still in the investment phase of reestablishing livelihoods (e.g., planting new cacao trees or purchasing young cattle to sell after one or two years) and were not yet earning income from these investments. The follow-up income measured at the time of the survey would therefore underestimate the true post-displacement income among these households.

Variables used in this PCA are a combination of binary, count, and ordinal, including asset ownership for nine items (refrigerator/freezer, washing machine, radio, color television, cellphone, car, truck/pickup, motorcycle, and bicycle), the number of houses/buildings owned, the number of rooms in the primary residence, whether the household had electricity, whether the household had a bathroom in the home (consisting of a modern toilet and shower), and three categories of land ownership (no land, below the median among owners (96 ha or below in 2012 and 100 ha or below in 2014), and above the median among owners). I top-coded the number of cellphones at four, other assets at two, houses/buildings

⁷PCA is a method for weighing related variables by the extent to which they explain variation within the population, and then reducing the number variables while maintaining much of the variation in the data (Jolliffe, 2002). Traditional PCA was developed to be used with continuous variables. Polychoric PCA is more accurate in estimating coefficients for non-continuous variables, and it computes coefficients for both owning and not owning assets, which can be informative in determining wealth (Kolenikov & Angeles, 2009; Moser & Felton, 2007).

owned at four, and number of rooms in the primary residence at eight (Garip, 2014). The higher values contained 3% or less of the sample for each variable. After conducting the PCA for the pooled baseline and follow-up data for the 165 households, I created a standardized wealth score for each household in each time period using the values from the first principal component. The possible range of the wealth score was 0–10. Wealth at baseline ranged from 0 to 8.3, and wealth at follow-up ranged from 1.3 to 10. Table 1 presents descriptive statistics for the variables included in the wealth index as well as the scoring coefficients generated by the polychoric PCA.

(c) Data analysis

In order to understand the factors associated with changes in wealth between baseline and follow-up I used ordinary least squares regression (OLS), with a continuous outcome variable created by subtracting the baseline from follow-up wealth score. In addition to socioeconomic changes, I examined the change in subjective well-being after being impacted by the dam. I first estimated a binary logit regression model on the likelihood of reporting that well-being improved.⁸ I then estimated a second binary logit model in order to understand the relationship between proximity to other households from the original community and change in well-being. I performed this analysis on a 108-household subset of the 165 households. These households had GPS data on their locations and lived in a rural area at follow-up. I chose to focus on rural households because urban households, by definition, live in close proximity to other households as well as to public services (health centers, schools, grocery stores, etc.) and therefore more easily access these resources. Rural households are more isolated, and therefore may depend more heavily upon nearby social networks for support, exchange of services, and social activities. Because building new networks after migration is a slow process, proximity to households from the prior community can serve as a proxy for social support. Using ArcGIS, I mapped the location of households and created a five-kilometer buffer around each household. I then calculated the number of other households from the study population within the buffer, and used this variable as a predictor in the model.

Control variables include age of household head (below the median age of 45 years and above the median); baseline wealth; change in wealth; compensation amounts (no compensation, credit payment (~R\$132,000), and quintiles of cash payment (R\$14,000–390,000, R\$400,000–550,000, R\$554,000–776,000, R\$780,000–1.39 million, and R\$1.40 million–4.2 million)); destination (did not move, moved to a municipality adjacent to the dam (Vitória do Xingu, Altamira, or Anapu), or moved to a farther municipality); and whether the household moved to a rural or urban destination. Table 2 presents descriptive statistics for the outcome and predictor variables, stratified by whether the household received compensation.

Lastly, I analyzed the qualitative data in order to explore the mechanisms underlying the quantitative findings on well-being change. I first examined the open-ended survey question

⁸Because of the small number of households in the “much better”, “same” and “much worse” categories of well-being change, I choose to estimate a binary logit model that compared improved well-being (much better and better) with the three other categories (same, worse, and much worse).

on reasons for changes in subjective well-being in order to understand the primary motivations behind well-being change among all 165 households. This enabled me to compare these motivations with the quantitative findings from my models in order to better understand the quantitative relationships, and to identify reasons for well-being change that could not be inferred from the quantitative data. I then analyzed the semi-structured interview data using NVivo 10, a qualitative data analysis software. In the semi-structured interviews, the respondents elaborated on their post-displacement conditions, which provided rich, descriptive, and detailed accounts of the drivers of well-being change identified in the survey data and open-ended question. I used the results from the open-ended survey question to generate an *a priori* set of themes associated with well-being change (e.g., “location”, “income”, and “obtained land”), and then coded the 39 post-displacement interviews based on these themes.

5. RESULTS

(a) Wealth and inequality

Table 1 displays the components of the wealth index, including asset, housing, and land indicators at baseline and follow-up as well as factor scores from the PCA analysis. Ownership of all assets aside from radios and bicycles increased in the approximately two-year period between baseline and follow-up. This is intuitive, as radios are replaced by televisions and bicycles by motorcycles or cars as households gain wealth. In particular, the percentage of households who owned at least one refrigerator/freezer rose from 33% to 94%, those who owned at least one washing machine rose from 28% to 85%, those who owned at least one car rose from 5% to 28%, and those who owned at least one pickup truck or larger truck rose from 4% to 23%. The number of houses or buildings owned as well as rooms in the primary residence increased slightly. The percentage of households with electricity rose from 46% to 87%, and those with a bathroom in the home rose from 21% to 82%. Lastly, the number of landless households decreased from 39% to 24%.

Figure 2 presents kernel density estimates of the distribution of the wealth index at baseline and follow-up. Panel *a* presents the pooled data and panel *b* presents the data stratified by whether or not the household received compensation. Results indicate that wealth increased among both the compensated and non-compensated groups. The increase was greater among the group that received compensation, though the difference was not statistically significant. In 2012 the mean wealth score was 3.11 (3.12 for compensated households and 3.09 for non-compensated households), and between baseline and follow-up the index increased by 2.81 for compensated households and 2.17 for non-compensated households.⁹

Regarding inequality, compensation and displacement could have resulted in three possible outcomes: (1) reproducing the structure of inequality that existed in the study area before-

⁹It is important to note that governmental cash transfer programs may have also contributed to wealth gains between the baseline and follow-up surveys. Brazil’s anti-poverty conditional cash transfer program, *Bolsa Família*, was received by 43 households at baseline and 40 at follow-up, with payments ranging from R\$60 to R\$380. In addition, rural retirement/pension payments were received by 39 households at baseline and 47 at follow-up with payments ranging from R\$500 to R\$2900. Households receiving these payments at follow-up did not experience significantly higher gains in wealth than those that did not ($p = 0.93$). Remittances did not play a strong role in household income, as only eight households at baseline and five at follow-up reported receiving remittances.

hand; (2) serving as an opportunity for poor families to improve their socioeconomic conditions vis-à-vis the wealthier families thereby reducing inequality; or (3) increasing inequality with richer households gaining wealth and poorer households facing socioeconomic stagnation or decline. Table 2 suggests that inequality within the study population declined for both groups, though the decline was more pronounced among households that received compensation. The standard deviation in wealth for compensated and non-compensated households decreased by 0.34 points and 0.25 points, respectively, despite increases in the mean. The positive changes in asset ownership and wealth, as well as the decline in inequality, suggest that in the first two years after displacement the compensation program improved socioeconomic conditions among the displaced population, particularly among poorer households. In addition, improvements in wealth among the households who did not receive compensation indicate that regional economic growth also had independent positive impacts on household-level wealth.¹⁰

(b) Modeling wealth and well-being change

Table 2 displays descriptive statistics for the variables included in the regression analyses, stratified by whether the household received compensation. Seventy-percent of compensated households reported better subjective well-being, while only 29% of non-compensated households did so. The age of household head and baseline wealth did not differ significantly between the compensated and non-compensated groups. Compensation payments ranged from R\$14,000 to R\$4.2 million, including 52 landless households who received credit payments of approximately R\$132,000. Among compensated households, 3% did not move from their original property, 71% remained within a municipality adjacent to the dam (Vitória do Xingu, Altamira, or Anapu), and 26% moved to a more distant municipality. Among non-compensated households 50% did not move, 42% remained within an adjacent municipality, and 8% moved to a farther municipality. Seventy-six percent of compensated households remained in a rural location, while 67% of non-compensated households did so. Lastly, among the 108 rural households with GPS data on their location, 57% of compensated households and 100% of non-compensated households had at least one other household from the study population within a five-kilometer radius of their home.¹¹

Table 3 presents the results of an OLS regression model predicting the change in wealth index between baseline and follow-up.¹² Baseline wealth is negatively associated with change in wealth, which suggests that poorer households experienced greater socioeconomic improvements than wealthier households. With each one-point increase in baseline wealth, a household had a 0.77-point lower change in wealth between baseline and follow-up. Controlling for baseline wealth, compensation amounts were significantly correlated with

¹⁰Construction of the dam brought much investment to the region, which led to direct and indirect employment opportunities. While only one individual in the study population worked for the dam building company, 12% of households engaged in non-agricultural work (e.g., hotel receptionist, factory worker, taxi driver) and 18% of households rented out houses or apartments (primarily in Altamira). Many of these income generation opportunities are likely related to dam construction and may disappear once construction ends. Eighty-two percent of households earned income from agricultural activities at follow-up, which are less sensitive to the boom-and-bust-cycle associated with development projects.

¹¹The locations of the 15 rural households who lacked GPS data were randomly distributed within six different municipalities.

¹²I also performed the regression using an unstandardized wealth score based on the first principal component. The same substantive pattern holds with a few changes in point estimates and levels of significance.

wealth change. As compared to households in the middle quintile of cash compensation, those who received no compensation and those who received a credit payment experienced lower increases in wealth. In addition, those in the top quintile of cash compensation experienced greater increases in wealth, while those in the first, second, and fourth quintiles did not differ significantly in wealth gains from the middle quintile. This finding suggests that cash compensation is more beneficial than credit, and that the majority of households who received cash were able to increase their wealth to a similar extent, despite differences in the amount obtained. Further, the model indicates that destination has a marginal effect on wealth change. Controlling for compensation, households who did not move from their original property experienced marginally higher wealth gains than those who moved to an adjacent municipality. These households were able to invest all compensation money in new assets, while many of the displaced households spent money on activities not captured in the wealth index such as renovating their new house, building corrals and fences for cattle, or replanting crops and cacao trees. In addition, households who moved to farther municipalities experienced marginally lower wealth gains, which may be due to the fact that farther moves incurred greater costs.¹³

Model 1 in Table 4 presents odds ratios from a binary logit model predicting improved subjective well-being among all 165 households. Results indicate that baseline wealth and change in wealth are not significantly associated with well-being change, suggesting that households assess well-being in terms of factors other than wealth, and that changes in well-being did not differ between poorer and richer households. Regarding compensation, compared to those who received the middle quintile of cash, those who received no compensation were 90% less likely to report better well-being. This is not surprising, given that non-compensated households observed others from their community receiving money to invest in new properties and assets, though they themselves did not receive any compensation. Further, households who received the highest category of compensation in compensation were 82% less likely to report better well-being than those in the middle quintile. This is a less intuitive finding, but indicates that those who received the most compensation had relatively high living standards at baseline and therefore had less to gain from receiving money and being displaced. These households were more likely to prefer their pre-displacement lives than were the less wealthy households. I will explore this finding further when discussing the qualitative results.

Destination also plays an important role in well-being change. As compared to households who moved to one of the three municipalities adjacent to the dam (Vitória do Xingu, Altamira, or Anapu), those who moved to more distant municipalities were 68% less likely to report better well-being. This finding is likely due to the fact that the adjacent municipalities are located closer to the city of Altamira (the region's urban hub) as well as to other households from the original community. Proximity to Altamira enabled these households to more easily access economic opportunities (e.g., transporting cacao to buyers in Altamira), access better social services (e.g., the regional hospital), take advantage of

¹³The dam building company transported the belongings, building materials, and livestock for the households if they moved within a 250 km radius of the original home, but did not cover the costs of searching for new property or moving the family to their newly purchased land.

economic development associated with the dam, and better maintain pre-displacement social networks. Moreover, moving to a rural destination was associated with significantly higher well-being than moving to a city, as households who lived in rural areas at follow-up were nearly 14 times more likely to report improved well-being than those who lived in a city.

Lastly, in order to examine the role of pre-existing social networks in well-being change, I estimated a binary logit model on the likelihood of improved well-being among households who remained in rural areas. Model 2 in Table 4 presents estimates for a 108-household subset of the sample who lived in rural areas at follow-up and contained GPS data on their locations. Similar to Model 1, households who received no compensation, as well as those who received the highest category of compensation, were less likely to report better well-being than those who received the middle quintile of cash. Model 2 adds a variable for whether the household has at least one other household from the study population living within a five-kilometer radius at follow-up. Households with other study households nearby are six times more likely to report better well-being than those without, suggesting that the ability to maintain social networks plays an important role in well-being. In addition, the coefficient for moving to a farther municipality loses significance, which could indicate that having members from the original community nearby buffered households from the negative effects of living farther away from Altamira and the origin community. Lastly, among rural households, older households were marginally less likely to experience improved well-being. This is likely due to the fact that moving to a new agricultural property often required labor intensive investments—building or renovating a house, clearing land for pasture, or constructing fences and corrals. While young households could easily undertake these tasks older households may have experienced greater challenges, thereby negatively impacting their life satisfaction.

(c) Qualitative data on well-being change

In order to explore the factors associated with well-being change in greater depth, I examined qualitative data from an open-ended survey question on reasons for well-being change, as well as from the 39 post-displacement semi-structured interviews. Table 5 presents reasons given by the 165 survey respondents for improved or same/worse well-being as well as the reasons broken up by households with younger and older heads. Sixty-four percent of households reported improved well-being (72% of younger households and 57% of older households). Among the 106 households with improved well-being, nearly 40% did not own land at baseline and stated that acquiring land was a primary reason that their life improved. This was a particularly important reason for improved well-being among younger households. For example, when asked about his post-displacement life, a former sharecropper stated, “I think it’s really great here, because if there wasn’t the dam we would have never bought land, we would still be living on the land of others”. In addition, a former sharecropper with three young children stated, “there we worked as sharecroppers with 3,000 cacao trees, and here we have 3,500 trees and they are ours...here everything is ours. Here the land provides enough for us to live peacefully”. These statements highlight the fact that displacement and compensation served as an opportunity for landless households to acquire property, which gave them greater autonomy over their lives, and in turn, a greater sense of well-being.

In addition, 28% of those who reported better well-being cited improved income or employment opportunities. Examples include households that moved to the city and earned better salaries than in the rural area, households who were able to purchase more productive land, as well as former sharecroppers who previously divided the profits earned from cacao with the landowner and after displacement were able to keep all of the income they earned. Further, 23% mentioned gaining assets as a reason for improved well-being. This included obtaining vehicles (a motorcycle, car, or truck), purchasing a house in Altamira in addition to rural property, buying additional apartments or houses to rent out, acquiring a larger property with more cacao trees, or living in a higher quality house.

Nineteen percent cited location as a factor, specifically the ability to buy land closer to Altamira, land near another urban area in the region, and/or land near paved roads. For example, a farmer who purchased property on a paved section of the Transamazon Highway 54-km from Altamira stated, “our life has already improved a lot...I was happy there, but here is better. Today I have more comfort. I almost never used to travel, I would stay for months without leaving the house. Today, I come to Altamira nearly every week”. Another farmer who purchased land in Anapu stated that before displacement it would take 2–3 h to reach Altamira due to poor road quality. His new property had access to higher quality roads, which enabled him to travel to the city of Anapu in less than an hour. Both distance and road quality allowed these households easier access to the city, which was beneficial in terms of selling their agricultural products, making purchases, and visiting friends and family. It is important to note that Norte Energia improved road quality in the original study area and surrounding region in order to access the construction sites, so if the household had remained in or near their original home they would have experienced these improvements as well. Lastly, 13% of those with better well-being cited access to electricity, which enabled households to refrigerate food, operate electronics, and illuminate the house at night without the high cost of purchasing and operating a generator.

Among the 59 households who reported the same or worse well-being, 37% referred to living in an urban area as a reason for their stagnation or decline in happiness (30% of younger households and 42% of older households). Specifically, survey respondents stated that rural life was calmer; that they missed their rural land and crops; that urban areas were hot, dusty, noisy, and polluted; that Altamira was violent; and that in the city the cost of living was very high and all food must be purchased versus grown. For example, an elderly man who moved to Altamira to be closer to health care stated, “firstly, [I miss] my friends, and secondly [I miss] what I had on my land. My manioc, yams, cupuaçu, oranges, limes... everything I needed. And here everything is about money”. These data support the quantitative finding that moving to an urban area was strongly correlated with declines in well-being. Migrating from a rural farm to the city led to substantial changes in a household’s environmental, economic, and social conditions. For many households, these changes outweighed the benefits of urban employment, infrastructure, and public services.

Thirty-four percent of households who reported the same or worse well-being cited changes in income or employment opportunities as a reason (57% of younger households and 31% of older households). Reestablishing secure income sources is particularly important for younger households, as younger families have had less time to accumulate assets and capital,

and also do not receive income support from retirement or pension payments. Households stated that they faced more difficulty finding employment after displacement, that their original land was more fertile and generated more income, or that migrating necessitated starting anew in terms of income generation (e.g., purchasing cattle that could not be sold for one to two years or planting cacao trees that would not produce fruit for three to four years). A farmer whose income declined after displacement stated, “there we had cacao and the land was good for raising chickens, and here it is neither good for chickens nor cacao...here is more difficult, because now we only have cattle.” This suggests that households who purchased property with poorer land quality had fewer on-farm options for income generation, and in turn, experienced a decline in well-being as it became harder to meet prior income levels.

Social ties also played an important role in well-being change. Among households with the same or worse well-being, 17% referred to the loss of their original community and 14% mentioned being far from family. Some households stated that they missed their original neighbors and had moved far from friends, and others stated that their formerly united families were now scattered throughout the region. Regarding family, a poor farmer who moved to Medicilândia said, “I wanted to buy land in Vitória do Xingu because...I was born and raised there. I never thought I would come here. My mother and all my relatives live there...but because we received little [compensation] we had to move farther, because closer is expensive...the bad thing is that our family stayed behind. On New Years the house used to be full of people. This year we spent New Years alone because, as they say, everything’s changed”. Another farmer discussed her loss of community, stating “there the majority of people grew up together, and the others were relatives. Whoever was not a relative grew up together and lived together for a long time, and here [that is not the case]”. These statements support the quantitative finding that the extent to which prior networks were maintained was an important factor in one’s assessment of well-being. Strong social and familial networks are central to socialization, the exchange of goods and services, and support during times of health or financial stress, and therefore help buffer households from well-being decline.

Lastly, as mentioned in the previous section, the quantitative data indicate that those who received the highest quintile of compensation were more likely to report worse well-being than those who received the middle quintile of cash compensation. An example comes from a wealthy farmer who received over R\$3 million in compensation and moved to a large, modern house in Altamira. He stated, “if I was still there I would be better than I am today. I had my car, my truck...every year I bought a new truck. I already had three houses here and another under construction, and all of this without receiving compensation”. This statement highlights that wealthy families had relatively high standards of living at baseline, whereas poorer families had more to gain from compensation and displacement in terms of property and assets. Additionally, among the eight households who received the highest category of compensation and reported worse well-being, six moved to an urban area. In contrast, among the nine households who received the highest category of compensation and reported better well-being, all moved to rural destinations. This suggests that within a rapidly urbanizing society like Brazil, households who received a large amount of capital may have expected that moving to a city would improve their standards of living. Despite being able to

purchase high quality urban homes, these households, like many others in the study population, were not accustomed to the more stressful urban lifestyle and environment.

6. DISCUSSION AND CONCLUSIONS

This study uses mixed-methods, longitudinal data to understand the short-term social impacts of displacement due to Brazil's Belo Monte Dam. Specifically, I focus on changes in wealth, inequality, and subjective well-being among a rural agricultural population. In the two years after displacement, wealth, as measured by an index of assets, property ownership, and housing conditions, increased between baseline and follow-up for 94% of the compensated households. Among the comparison group—households within the study population who did not receive compensation by the time of follow-up surveys—wealth also increased for nearly all households, though to a lesser extent (2.17 points versus 2.81 points for compensated households). This indicates that compensated households experienced socioeconomic improvements and that regional economic development positively impacted wealth among non-compensated households as well. It is not possible to distinguish whether wealth change among the control group was due to overall developments in Brazil's economy or to local investments made by the dam building company (Norte Energia, 2011).

Nevertheless, this finding indicates that, contrary to the case of many prior dams, construction of the Belo Monte Dam has not adversely impacted the local displaced population socioeconomically in the first few years after displacement; in fact, their standard of living improved over baseline levels. By examining the distribution of wealth at baseline and follow-up as well as modeling factors associated with wealth change, I found that poorer families gained more from compensation and displacement, which reduced inequality. Taken together, these findings suggest that the compensation program was effective in improving wealth for the vast majority of the population, and particularly for the poorest, most vulnerable households.

Subjective well-being captures a holistic assessment of happiness, and therefore offers insights beyond those that monetary measures can capture. The finding that the households who received the highest amount of cash compensation—between R\$1.4 million and \$4.2 million—were less likely to improve their well-being supports the finding that poorer households, who improved their economic position in both absolute and relative terms, experienced greater gains to subjective well-being (Easterlin, 1995; Helliwell & Putnam, 2004; Knight *et al.*, 2009). Further, although 94% of households experienced positive wealth change, only 64% stated that their well-being improved after being impacted by the dam. This suggests that while economic factors such as property ownership, income, and job opportunities do impact well-being, other factors also play a key role in the assessment of one's quality of life.

Quantitative and qualitative data indicate that location was key in determining well-being change. Households who moved to Altamira or other urban areas in the region were substantially less likely to state that their well-being improved than those who remained in rural areas. Brazil is a rapidly urbanizing country in which 85% of the population lives in cities (World Bank, 2015). Cities provide easy access to employment opportunities, social

networks, health care, and other public services, and therefore it is not surprising that some study households expected that moving to a city would be beneficial. Yet results indicate that households who maintained rural lives, which more closely resembled their pre-displacement conditions, were much happier. This echoes the finding by Knight and Gunatilaka (2010) that rural–urban migrants in China had lower subjective well-being than rural households, due in part to expectations about urban life that were not met upon settling in the city. In addition, in low- and middle-income countries, rural–urban migrants tend to be young adults who stand to gain the most over time from urban employment opportunities (Taylor & Martin, 2001; Todaro, 1980). Among the displaced households who moved to urban areas, nearly half had household heads over age 50. Older households may have a harder time coping with the lifestyle shock that accompanies rural–urban migration than would young migrants moving to seize urban employment opportunities.

In addition, both quantitative and qualitative analyses indicate that maintaining social and familial networks was an important determinant of well-being. Rural households who remained in close proximity to other households from the original community were more likely to report improved well-being, and many households mentioned moving far from friends or family as a reason for well-being decline. The majority of households from the study population had lived in the original community for decades, if not their entire lives. Remaining near family or friends enabled households to preserve local support systems, which is a robust predictor of subjective well-being (Helliwell & Putnam, 2004; Yip *et al.*, 2007). The ability for households to maintain these support systems after displacement was therefore critical in preventing well-being decline.

This analysis is subject to three primary limitations. First, the study relied on a small comparison group—24 households who were expected to be compensated at baseline but received no compensation by the time of follow-up data collection. An ideal study design would incorporate a control group consisting of a larger number of households from the region who were not impacted—directly or indirectly—by the dam. Identifying appropriate households for the control group would have been difficult, as construction of Belo Monte has led to socioeconomic impacts throughout the region. The lack of a sizable control group precludes an assessment of the extent to which wealth increase can be attributed to compensation, dam-related economic development, or general development within Brazil.

Second, this study examined displacement among a subset of the rural population displaced due to Belo Monte, not a representative sample of the entire displaced population. These findings therefore cannot be generalized to the dam as a whole. The majority of displaced households lived in the city of Altamira, and it remains to be seen whether urban displacement follows similar patterns of wealth and well-being changes. The approximately 4,300 urban households expected to be displaced in Altamira will undoubtedly face a different set of challenges in restoring livelihoods, and may experience more negative, similar, or more positive outcomes than the households I studied in this paper.

Third, this study examined the short-term impacts of displacement, following up with households only one to two years after they moved. Scudder and Colson (1982) argued that during the first few years after displacement, households are in a transition phase, in which

they adjust to their new communities and rebuild livelihoods. Scudder and Colson find that living standards often drop during this phase. During the next stage (which many displaced communities never reach), economic development occurs and living standards improve. Contrary to Scudder and Colson (1982), I find that during the transition phase living standards improved for most households. Yet my data do not enable me to understand whether households are able to maintain these improved socioeconomic conditions over the longer term—which is a key determinant of the success of a resettlement program.

A recent study of displacement due to the Three Gorges Dam did examine the longer term impacts of displacement (Wilmsen, 2016). Wilmsen followed up on an earlier study in which she interviewed displaced households in 2003—only a few years after displacement—and found that the households experienced negative socioeconomic and livelihood effects (Wilmsen *et al.*, 2011). In 2011, she re-interviewed the same households and found that they had achieved substantial gains in income, food security, and well-being, which she attributed in part to a resettlement policy focused on benefit sharing and livelihood reconstruction (Wilmsen, 2016). Therefore, in order to more comprehensively understand how displacement affects the wealth and well-being of the households displaced by Belo Monte, it is crucial to follow up with the households after dam construction ends. This longitudinal perspective will offer insight into whether the positive outcomes of the compensation program are sustained over the longer term, or whether they simply reflect short-term gains in wealth associated with the large windfall of cash to the households.

In conclusion, the Belo Monte case offers several lessons to inform the design of future resettlement programs. First, this study finds that a cash-based resettlement strategy can positively impact wealth and well-being in the short term. In order to function effectively, compensation must be sufficient to enable households to purchase property and assets that equal or exceed pre-displacement conditions. In the case of Belo Monte, compensation liquefied assets, providing households with the capital for investments that would not have been possible otherwise. Future research will be necessary to understand whether these gains are maintained over the long term, or whether households will experience socioeconomic and well-being declines in subsequent years. It is only after evidence of long-term sustained improvement that the resettlement program can be considered a success (Scudder & Colson, 1982).

Second, maintaining social networks after displacement is key to enhancing well-being. While many households were able to utilize networks to find property near friends and family (Randell, 2016), others became isolated after displacement, which contributed to well-being decline. Resettlement programs should assist displaced households in purchasing new property near one another so that they can maintain social support systems. Lastly, a number of households experienced positive wealth change but lower subjective well-being after displacement. Well-being is determined by a complex array of factors including location, the level of autonomy over one's life and livelihood, employment opportunities, and access to social networks. Resettlement programs should therefore work closely with households—beyond simply compensating them—to ensure the sustained improvement of both their socioeconomic conditions and well-being.

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Figure 1. Map of study area including baseline properties and migration destinations.
Note: The exact location of households has been altered in order to protect the privacy of respondents.

Figure 2.
Kernel density estimates of wealth index, 2012 and 2014–15.
Note: Top figure displays the pooled data and bottom figure displays the data stratified by whether the household was compensated.

Table 1

Descriptive statistics and scoring coefficients from PCA for variables used in constructing the wealth index, 2012 and 2014–15

2012					2014–15					2012					2014–15				
					Factor Score					Percent					Factor Score				
Assets:																			
Refrigerator/freezer										Housing and land:									
0	0.67	0.07			–0.39					0	0.18	0.12			–0.27				
1	0.32	0.78			0.15					1	0.50	0.56			–0.04				
2+	0.01	0.16			0.70					2	0.21	0.23			0.14				
Washing Machine																			
0	0.72	0.18			–0.34					3	0.07	0.07			0.25				
1	0.28	0.76			0.24					4+	0.04	0.03			0.37				
2+	0.00	0.05			0.87					Rooms in primary residence									
Radio										1	0.02	0.01			–0.48				
0	0.39	0.51			0.07					2	0.05	0.02			–0.35				
1	0.55	0.48			–0.04					3	0.13	0.08			–0.24				
2+	0.06	0.01			–0.16					4	0.32	0.30			–0.10				
Color television										5	0.25	0.30			0.05				
0	0.48	0.08			–0.43					6	0.13	0.18			0.16				
1	0.47	0.81			0.11					7	0.04	0.07			0.25				
2+	0.04	0.11			0.67					8+	0.06	0.05			0.36				
Cellphone										House has electricity									
0	0.36	0.10			–0.34					0	0.54	0.13			–0.39				
1	0.44	0.40			–0.04					1	0.46	0.87			0.19				
2	0.13	0.33			0.19					House has bathroom									
3	0.05	0.09			0.35					0	0.79	0.18			–0.29				
4+	0.02	0.08			0.53					1	0.21	0.82			0.28				
Car										Land ownership:									
0	0.96	0.72			–0.07					Owns no land						0.39	0.24	–0.20	
1	0.04	0.27			0.37					Low (6median)						0.31	0.43	0.00	
2+	0.01	0.01			0.69					High (>median)						0.30	0.33	0.20	

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		2012		2014–15		2012		2014–15	
		Percent		Factor Score		Percent		Factor Score	
Pickup or truck									
0	0.96	0.77			−0.07				
1	0.04	0.21			0.41				
2+	0.00	0.02			0.71				
Motorcycle									
0	0.44	0.30			−0.11				
1	0.48	0.57			0.04				
2+	0.07	0.13			0.19				
Bicycle									
0	0.76	0.89			0.02				
1	0.15	0.08			−0.07				
2+	0.08	0.02			−0.12				
<i>N</i>		165							

Variance explained by first component: 0.38.

Table 2

Descriptive statistics for variables used in regression analyses

	Compensated Mean/percent	Not compensated Mean/percent	Diff.
Outcome variables:			
Change in subjective well-being:			***
Better	0.70	0.29	
The same	0.07	0.33	
Worse	0.23	0.38	
Difference in wealth index between baseline and follow-up	2.81 (1.86)	2.17 (1.36)	
Predictor variables:			
Household head age in 2012:			
20–44	0.49	0.50	
45–80	0.51	0.50	
Baseline wealth index	3.12 (1.78)	3.09 (2.24)	
Compensation:			
Credit payment (~R\$132,000)	0.37		
1st quintile of cash (R\$14,000–390,000)	0.13		
2nd quintile of cash (R\$400,000–550,000)	0.13		
3rd quintile of cash (R\$554,000–776,000)	0.12		
4th quintile of cash (R\$780,000–1.39 million)	0.13		
5th quintile of cash (R\$1.4 million–4.2 million)	0.12		
Destination:			
Did not move	0.03	0.50	***
Moved to adjacent municipality	0.71	0.42	**
Moved to a farther municipality	0.26	0.08	+
Lives in a rural area	0.76	0.67	
<i>N</i>	141	24	
Rural household has at least one other household from the study population within a 5-km radius	0.57	1.00	**
<i>N</i>	94	14	

Standard errors in parentheses.

⁺ $p < 0.1$,

 $p < 0.001$ (chi-squared, two-tailed Fisher's exact test comparing compensated with non-compensated households).

p < 0.01,

p < 0.001

Table 3

OLS model predicting change in wealth index

Variable	β	Std. error
Household head age in 2012 [45–80 is baseline]		
20–44	0.23	0.21
Baseline wealth score	−0.77***	0.06
Compensation [R\$554,000–776,000 is baseline]		
No compensation	−1.46**	0.45
Received credit payment (~R\$132,000)	−1.06**	0.35
1st quintile of cash (R\$14,000–390,000)	−0.45	0.42
2nd quintile of cash (R\$400,000–550,000)	−0.09	0.42
4th quintile of cash (R\$780,000–1.39 million)	0.30	0.43
5th quintile of cash (R\$1.4 million–4.2 million)	1.00*	0.44
Destination [Moved to adjacent municipality is baseline]		
Did not move	0.80 ⁺	0.44
Moved to a farther municipality	−0.45 ⁺	0.25
Lives in a rural area	−0.35	0.25
Constant	5.76***	0.42
<i>N</i>	165	
<i>R</i> ²	0.56	

⁺ $p < 0.1$,

* $p < 0.05$,

** $p < 0.01$,

*** $p < 0.001$.

Table 4

Odds ratios from binary logit models predicting improved subjective well-being

Variable	Model 1		Model 2	
	OR	Std. error	OR	Std. error
Household Head Age in 2012 [45–80 is baseline]				
20–44	1.59	0.69	2.83 ⁺	1.77
SES score at baseline	0.91	0.16	1.00	0.27
Difference in SES score between baseline and follow-up	1.00	0.16	1.26	0.33
Compensation [R\$554,000–776,000 is baseline]				
No compensation	0.10 [*]	0.11	0.01 [*]	0.02
Received credit payment (~R\$132,000)	0.54	0.44	0.19	0.25
1st quintile of cash (R\$14,000–390,000)	1.38	1.33	0.72	1.16
2nd quintile of cash (R\$400,000–550,000)	0.38	0.34	0.44	0.63
4th quintile of cash (R\$780,000–1.39 million)	0.48	0.45	0.76	1.26
5th quintile of cash (R\$1.4 million–4.2 million)	0.18 ⁺	0.17	0.11 ⁺	0.15
Destination [Moved to VX, ATM, or AN is baseline]				
Did not move	0.38	0.33	0.62	0.82
Moved to a farther municipality	0.32 [*]	0.17	0.45	0.28
Lives in a rural area	13.71 ^{***}	7.44		
Has a least one study household within a 5 km radius			6.35 [*]	4.61
Constant	1.14	1.45	3.21	6.26
N	165		108	
Pseudo R2	0.24		0.30	

⁺ $p < 0.1$,

^{*} $p < 0.05$,

^{***} $p < 0.001$.

Note: The sample for Model 2 is rural households with GPS data.

Table 5

Reasons for well-being change

	Full sample	Younger households	Older households
Better well-being			
Now owns land	0.39	0.53	0.21
Greater income/employment opportunities	0.28	0.33	0.25
Gained assets	0.23	0.26	0.19
Location	0.19	0.19	0.19
Has electricity	0.13	0.09	0.19
<i>N</i>	106	58	48
Same or worse well-being			
Living in urban area	0.37	0.30	0.42
Fewer income/employment opportunities	0.34	0.57	0.31
Loss of community	0.17	0.13	0.19
Far from family	0.14	0.13	0.14
<i>N</i>	59	23	36
Total households	165	81	84

Notes: Includes reasons stated by >10% of respondents in the full sample.

Respondents provided multiple reasons, so proportions do not add up to 1.

Younger households include those with heads aged 20–45 at baseline, and older households include those with heads aged 46–80 at baseline.