Environmental Impacts of Cash Transfer Programs: Implications for the Welfare of Poor Communities in Developing Countries

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Selected Paper prepared for presentation at the 2018 Agricultural & Applied Economics Association Annual Meeting, Washington, D.C., August 5-August ***7***

[1] We acknowledge the support of The David and Lucile Packard Foundation grant 2014-40350 and World Bank Global Environmental Facility CCRES project. We also acknowledge the support of our partners at Palawan State University, The University of Queensland, and The University of the Philippines, Diliman.

Key Words: Cash transfers, Natural resources, Fisheries, Poverty, Bioeconomic models, CGE
JEL code: Q22/Q56/O12

Abstract:

Cash transfer programs are one of the most common poverty reduction tools used by governments and international agencies. Recent work has shown that cash transfer programs may increase local production levels and have negative consequences for local environmental resources. However, thus far, impact evaluation work on cash transfers has not captured how impacts on local natural resources affect the welfare of households that depend on these resources for food and income. We combine a bioeconomic local general equilibrium model with household survey data to simulate the impacts of an existing cash transfer program in the Philippines. We illustrate how impacts of cash transfers ripple through a local economy to affect demand for a natural resource (fish) and the welfare implications this has on different socioeconomic groups, including households not participating in the transfer program. We find that environmental impacts from the cash transfer program negatively affect the local economy and reduce the benefits of the program for all households. Households experience higher real incomes as a result of the program, but higher demand for fish results in a decline in the local fish stock. This erodes households' real income gains, particularly for fishing households that rely heavily on the fishery. In the case of fishing households that are not recipients of the cash transfers, they eventually experience real incomes below their baseline level. If imports that are close substitutes for local fish are available, impacts on the local fish stock are smaller. However, importing fish comes with tradeoffs. Greater reliance on imports results in a leakage out of the local economy and smaller local economic benefits of the program. The modeling framework used here can help improve impact evaluations by accounting for how cash transfer programs affect local natural resources and how these environmental impacts affect the welfare of all households.

Section 1: Introduction:

Cash transfers are an increasingly common development tool used to reduce poverty. In part, interest in cash transfer programs derives from successful instances of reducing poverty, which have been documented with rigorous economic studies (Sadoulet et al., 2001; Rawlings and Rubio, 2005; Handa and Davis, 2006). Several studies argue that assessing economic spillovers from cash transfers, including impacts on the nonrecipient households, are an important part of assessing the full impact of cash transfer programs (e.g., Thome et al., 2013; Filipski et al., 2015). Recent work suggests that cash transfer programs may be responsible for environmental impacts such as increased deforestation (Alix-Garcia et al., 2013); however, researchers have not been able to determine the welfare impacts of this deforestation. The welfare consequences of local environmental impacts are potentially large, given that poor communities often depend heavily on natural resources for food and income. In this paper, we use a bioeconomic general equilibrium model parameterized with local data to illustrate how environmental impacts of cash transfer programs arise and the welfare implications they have for households.

Cash transfer programs provide assistance in the form of regular cash payments to households. These payments may be unconditional, or they may be conditioned on specific criteria, such as regular school attendance and regular health checkups for children. Programs typically include targeting criteria for participating households (e.g., income below the poverty line, asset poor, fostering orphans, etc.). Cash transfer programs are common throughout the developing world. For example there are several large-scale programs in Latin America, such as Mexico's PROGRESA program and Brazil's BOLSA FAMILA program. They are now also a regular part of poverty alleviation strategies in sub-Saharan Africa (Davis et al., 2012; Davis et al., 2016). In addition to being widespread, the scale of many cash transfer programs is also significant. Mexico's PROGRESA program has an annual budget of $2.6 billion, or half a percent of GDP. The program makes payouts to 40 percent of rural households and increases per capita income of those recipients by an average of one-third (Alix-Garcia et al., 2013).

One of the reasons for the popularity of cash transfer programs is the possibility of implementing programs using a randomized control trial (RCT) format. RCTs are considered by some researchers to be the highest standard for impact evaluation for development programs (Banerjee and Duflo, 2012). The proposed benefit of the RCT method is that it provides a clean identification of the impact of treatment on the treated by establishing a control group that is otherwise identical, on average, to the treatment group. The RCT format has been used in a variety of settings to assess the impact of cash transfer programs on poverty levels and other outcomes such as school attendance, health, and production (e.g., Skoufias, 2005; Covarrubias et al., 2012).

While RCTs have been widely applied as impact evaluation tools for development programs, several studies have illustrated how the potential for spillovers to nonrecipient households (i.e., control group contamination) may result in a misrepresentation of the true impact of the program. One notable example is an assessment of a deworming program in Kenya that gave free deworming treatments in randomly selected schools (Miguel & Kramer, 2004). Researchers found that schools that did not receive a deworming treatment also showed improvement in pupil attendance, possibly due to lower transmission rates when children from the treated and non-treated schools interacted outside of school. Given that cash transfer programs inject a relatively large amount of money into local economies, the potential for economic spillovers is high. Several recent studies have addressed this by using economy-wide modeling frameworks to simulate the impacts that cash transfers have on both recipient and nonrecipient households. As Thome et al. (2013) show, households that receive cash transfers and spend the funds locally are a conduit through which the cash transfer program can affect the entire local economy. They show that in the case of Kenya’s cash transfer program for households with orphans and vulnerable children, the program resulted in income benefits for nonrecipient households and an increase in local agricultural production. The production responses were largest for nonrecipient households. Filipski et al. (2015) show a similar potential for supply responses by wealthier nonrecipient households that own greater amounts of capital.

There is increasing recognition that the spillovers from cash transfer programs are not limited to income and production. Given the capacity of cash transfer programs to affect local demand and production levels, it is also possible that they impact local environmental quality and natural resources. Alix-Garcia et al. (2013) show that the Mexican conditional cash transfer program PROGRESA increased local deforestation levels by increasing the demand for land-intensive goods such as meat and dairy products. They also show that the local environmental impacts of the cash transfer program are mediated by markets, finding that the impact on local deforestation was bigger in locations where there was a lower density of roads (a proxy for openness to trade).

An unanswered question is how environmental impacts from cash transfer programs affect the welfare of local households. Families in communities where cash transfer programs are implemented often depend heavily on natural resources for their livelihoods, either for income generating activities or for sources of consumption (e.g., food or materials; see World Bank, 2007). These natural resources frequently are open-access resources subject to overharvesting and market failures. Thus, important questions with regard to conducting accurate impact evaluations for cash transfer programs are the extent to which there are there environmental impacts and how these impacts affect the welfare of local households (both recipients of the cash transfers and nonrecipients).

To answer these questions, we build on prior work assessing the impact of cash transfer programs in several ways. Recent work has shown the value of using local CGE models parameterized with household survey data to assess how policies in other sectors (e.g., agriculture or tourism) indirectly affect natural resources (Gilliland et al., 2017; Manning et al., 2013; Taylor et al., 2003). Similar to the modeling framework in Gilliland et al. (2017) and Manning et al. (2016), we link a local economy-wide model to a bioeconomic model of a fishery. We use this model to simulate the environmental impacts of a cash transfer program and how these environmental impacts affect the welfare of households, both beneficiaries and nonbeneficiaries. We apply the model to a municipality in the western Philippines where a government run conditional cash transfer program called the *Pantawid Pamilyang Pilipino Program*[2] (4Ps) is being implemented. The model disaggregates households based on their

[2] The English translation of the program name is Bridging Program for the Filipino Family. The program was also formerly known as *Ahon Pamilyang Pilipino*.

participation in the 4Ps program and whether they engage in fishing in order to assess impacts on different socioeconomic groups.

We find that all households initially benefit from the 4Ps cash transfer program given that nonrecipient households benefit indirectly through economic spillovers. However, higher demand for fish results in a decline in the local fish stock over time. All households suffer from the decline in the fish stock, particularly fishing households, which rely heavily on the fishery. Fishing households that are not recipients of cash transfers eventually experience real incomes below their baseline level. The impacts of cash transfers are sensitive to assumptions about trade. If imports that are close substitutes for local fish are available, the impact of the cash transfer program on the local fish stock is smaller. However, greater reliance on imports results in a leakage out of the local economy and therefore smaller local economic benefits from the program. This modeling framework helps illustrate how accounting for both economic spillovers and environmental impacts can improve impact evaluation efforts for cash transfer programs.

The rest of the paper is organized as follows. The next section provides a brief description of the Philippines' 4Ps cash transfer program. Section 3 outlines the structure of the model used to simulate the impacts of the cash transfer program. Section 4 outlines the data and how they are used to parameterize the model. Section 5 discusses the results of the simulations. Finally, Section 6 presents a discussion of policy implications.

Section 2: Description of the *Pantawid Pamilyang Pilipino Program* (4Ps):

The *Pantawid Pamilyang Pilipino Program* (4Ps) is one of the primary social protection efforts of the Philippine Government. The Philippines face considerable challenges related to poverty, health and low educational attainment. Despite recent national economic growth, approximately one quarter of the population in the Philippines remains below the national poverty line (DSWD and World Bank, 2014). In the lowest income quintile, one-fifth of school-age children are not enrolled and coverage of childhood immunization is only 70 percent. The 4Ps conditional cash transfer program is a response to these challenges. It provides payments to poor households conditional on meeting goals related to children's education, children's health, and the use of maternal health services.[3] The goal of the program is to break the intergenerational cycle of poverty while also providing for the immediate financial needs for households (Fernandez and Olfindo, 2011). The 4Ps program is run by the Department of Social Welfare and Development (DSWD) along with support from the Department of Health, the Department of Education, the Department of the Interior and Local Government, and the Land Bank of the Philippines.

Starting from a pilot program of 7000 households in 2007, the 4Ps program has scaled up to include 4.4 million households (21 percent of Philippine households) as of 2015 (DSWD and World Bank, 2014). The 4Ps program is modeled after and is similar in scale to large cash transfer programs in Latin America, including PROGRESA (27 percent of the Mexican population) and Bolsa Familia (29 percent of the Brazilian population). The 4Ps program budget in 2014 was 62.2 billion PHP (1.5 billion USD), which is 0.5 percent of GDP and 2.8 percent of

[3] More detailed information about the 4Ps program can be found in Fernandez and Olfindo (2011) and at the program's website: http://www.gov.ph/programs/conditional-cash-transfer/.

the Government's budget. Most of the program is financed out of the government's budget, with about 22 percent coming from external financing from development partners (Acosta and Velarde, 2015). The 4Ps program was implemented at this study's field site, El Nido municipality, Palawan, during the second phase of the implementation (Set 2) during March to July 2009. Approximately 40 percent of households in El Nido participate in the 4Ps program.

Households must meet several criteria in order to be eligible for the program. First, they must live in designated poor provinces and poor municipalities within those provinces. These provinces and municipalities are designated by official poverty indices derived from the Family Income and Expenditures Survey (Philippine National Statistics Office) and Small Area Estimates (National Statistics Coordination Board). Eligible poor households within these municipalities are designated as poor using a household targeting system that employs a proxy means test to identify a household's economic condition based on characteristics that include assets, household composition, housing conditions, access to basic services, education, and regional variables. Participating households must have at least one child aged 0-18 years old or a pregnant woman.[4] Finally, a household must be willing to commit to the program conditionalities.

Households that participate in the 4Ps program agree to the following. Pregnant women must receive the provided pre- and postnatal care and parents or guardians must attend family development sessions that focus on topics such as health, nutrition and parenting. Children aged 0-5 must have regular free preventative health checkups and appropriate vaccines. Children aged

[4] When initially implemented, the program covered only children of age 0-14, however this recently has been changed to include children up to 18 years of age. This was done in hopes of having positive impacts on older school-age children.

6-14 are required to receive free deworming pills twice per year. Finally, children and beneficiaries aged 6-18 must enroll in school and must maintain an attendance rate of 85 percent each month.

The monetary benefits of the 4Ps program come in the form of several different types of grants. Each household may receive a health grant of 500 Philippine pesos (PHP) (10.06 USD) each month for a total of 6000 PHP (120.72 USD) per year.[5] In addition, households receive education grants of 300 PHP (6.04 USD) per child per month for 10 months. Up to three children per household may receive education grants from the program. The maximum a household may receive from the 4Ps program is 15,000 PHP (301.81 USD) per year. The cash grants are distributed to households through the Land Bank of the Philippines or alternative schemes such as Global G-Cash or rural bank transactions.

There are no impact evaluations of the 4Ps program specific to this study's field site, El Nido municipality; however, several impact evaluations have been conducted in other locations and on a broader scale. A national-scale study by the DSWD using regression discontinuity found that the 4Ps program was achieving many of its stated objectives (DSWD, 2014). This study showed that the 4Ps program improved access to postnatal care, improved usage of health services for children, and helped keep older children in school. An impact evaluation using an RCT design and pilot study data from a more limited number of provinces (Luzon, Visayas, and Mindinao) found that the program was associated with an increase in school enrollment by 10 percentage points for children aged 3-5 years old and by 4.5 percentage points for children aged

[5] This is using the current conversion rate of 49.7 Philippine pesos to one US dollar. Analysis of the data collected for this paper in 2015 uses the conversion rate at that time which was closer to 45 Philippine pesos to one US dollar.

6-11 years old (DSWD and World Bank, 2014). It also showed that the program improved the health status of poor children, including a 10 percentage point reduction in severe stunting.

Tutor (2014) assessed the impacts of the 4Ps program on consumption using propensity score matching and data from the nationally representative Annual Poverty Indicators Survey. This study found that for 4Ps participant households that fall within the poorest income quintile in the Philippines (60 percent of households participating in the 4Ps program) there were significant impacts on total consumption expenditures: per capita consumption expenditures increased by 3 to 5 percent of pre-program levels. The increase in per capita total expenditures was driven by spending on food, including carbohydrates, protein sources, and fruits and vegetables. The national scale study by the DSWD using regression discontinuity found increases in consumption expenditures only under some model specifications—those that included wider bandwidths in the regression discontinuity analysis (DSWD, 2014). This is consistent with the findings of Tutor (2014) that large increases in consumption expenditures are concentrated among poorer households, not those in closest proximity to the eligibility threshold. The RCT using pilot study data found no impact on total consumption expenditures; however, this study was on a limited subset of households (only three provinces) and did not consider heterogeneous impacts.

Section 3: The Bioeconomic Local CGE model

This section provides an outline of the bioeconomic local CGE model used to simulate the impacts of the 4Ps cash transfer program on households and local natural resource use. A full listing of the model equations can be found in the appendix (Table A1 and A2). Households in the model are aggregated into representative household groups according to their participation in the 4Ps program and their engagement in the fishing sector (Table 1). Those who claimed to receive 4Ps transfer payments are recipients; those who did not are nonrecipients. Those households that were engaged in fishing in the 12 months prior to surveying are designated as fishing households; those that were not engaged in fishing are designated as nonfishing households. The model also includes a category for nonresidents who own businesses in the municipality, but do not live in El Nido. This disaggregation of household types allows us to simulate the impacts of the cash transfer program on different types of households according to their links to the 4Ps program and the natural resource.

Table 1
Accounts in the Village-scale CGE Model

Endogenous Accounts
Production activities:
Hotels and restaurants
Tourism activities
Retail
Agriculture
Fishing
Other services
Household groups:
Recipient, fishing
Recipient, nonfishing
Nonrecipient, fishing
Nonrecipient, nonfishing
Nonresidents
Factors:
Family Labor
Hired Labor
Capital
Land
Purchased inputs
Exogenous Accounts
Tourism expenditures
Government
Rest of World

Household groups engage in various production activities based on what activities were reported in household surveys. The six different production activities included in the model are hotels and restaurants, tourism activities, retail, agriculture, fishing, and other services (Table 1). Hotels and restaurants are combined because they are frequently joint businesses in El Nido. Tourism activities include activities such as boat tours and snorkeling/diving trips. Agriculture includes the production of crops (the most common being rice) and livestock products. Fisheries products are combined into one aggregate fish good. Production is modeled using Cobb-Douglas with constant returns to scale. Intermediate goods are demanded as fixed portions of output (i.e., Leontief processes). Fixed factors in the model include land and capital. While it is possible that cash transfer payments could relax liquidity constraints for recipient households, recent work on the 4Ps program has found that the transfers have not resulted in investment in new assets by recipient households (DSWD and World Bank, 2014). It is possible that income spillovers benefitting nonrecipient households could result in those households investing in capital (Filipski et al., 2015), though impacts felt by nonrecipient households are relatively small. Nonetheless, future work would benefit from accounting for possible adjustments to the capital stock over time.

The fishing sector is integrated with the fish population as follows. In the fishing sector, the fish stock level is an additional factor of production. That is, the number of fish in the water is an important determinant of the number of fish on the dock. For this reason the value-added production function in the fishing sector is

$$Y_{fish,t} = A_{fish} \prod_f FD_{fish,f,t}^{\beta_{fish,f}} * X_t^{\beta_{stock}} \quad (1)$$

Where $Y_{fish,t}$ is value added produced in time t, A_{fish} is a shift parameter, $FD_{fish,f,t}$ is factor demand for factor f in the fishing sector, X_t is the fish stock level, and the β terms are output elasticities. This assumes that within a given time period, the fish stock level is considered fixed. Constant returns to scale are also assumed in the fishing sector, meaning that $\sum_f \beta_{fish,f} + \beta_{stock} = 1$. We also assume that a decrease in stock size affects input costs (e.g., petrol) to reflect the fact that search costs may increase when fish are less abundant. This search cost function takes the form

$$idsh_{fishing,t} = \frac{a}{(X_t)^n} \tag{2}$$

where $idsh_{fishing,t}$ is the intermediate demand share for retail goods (i.e., petrol). Intermediate demand shares control input costs. The intermediate demand share is the share of one unit of value of output (at baseline prices) that must be expended on inputs to produce that one unit of output value. Thus, this formulation is equivalent to scaling up cost per unit catch as the stock size decreases. The value of a is derived from cost data and n reflects how quickly costs increase as the fish stock declines.

The fish stock adjusts over time in response to fishing pressure. To account for this, we link the village-scale CGE model described above with a dynamic fish population model. For simplicity, we assume that growth of the stock is logistic. The population dynamics for the fish stock take the following form

$$X_{t+1} = X_t + \gamma X_t \left(1 - \frac{X_t}{K}\right) - h_t\ . \tag{3}$$

where X_t is the fish stock level, γ is the intrinsic growth, K is the fish population carrying capacity, and h_t is the level of fish harvested (in kilograms) in time t.

We assume that individuals in the fishery are not forward-looking or strategic in their decisions about how much labor to dedicate to fishing. That is, they do not take into account how their actions may affect the fish stock and profitability in the future or how the actions of others will impact their ability to catch fish in the current period. These assumptions are consistent with an open-access setting with many fishing agents acting independently with little information sharing. Factor demands in the fishery reflect the open-access nature of the fishery. Since labor and capital collect some share of value-added created by the fish stock, these factors will be overallocated. Since it is not known how the value added attributable to the stock is divided among the remaining factors we follow Manning et al. (2016) and assume each factor collects a share of the value-added attributable to the stock according to that factor's relative contribution to value-added. This accounts for the over-allocation of factors to fishing due to the open-access nature of the fishery and ensures that effort enters the fishing sector until the economic profits in the sector are driven to zero.

For goods that can be imported (agricultural goods and fish), domestically produced goods and imported goods are combined into a composite good according to an Armington function. The degree of substitutability between domestically produced goods and imported goods is controlled by an Armington elasticity. Differing degrees of substitutability could arise for several reasons. Domestically produced goods and imports may be of different types, such as different species of fish or different varieties of agricultural crops. Substitutability also may depend on factors such as the freshness of imported fish relative to locally caught fish.

Household incomes come from explicit or implicit payments to household-owned factors and from exogenous sources, such as the 4Ps cash transfer program. Household utility is modeled using a constant elasticity of substitution (CES) function with an elasticity of substitution greater than unity. This results in a CES demand system with nonzero cross-price elasticities. Households demand various locally produced goods, or in the case of goods that can be imported, Armington composite goods. In addition, they make some purchases outside of the local economy. Demand by tourists is also derived from a CES utility function.

The consumption demands, tourist demands, sector outputs, Armington composite commodities, intermediate input demands, factor demands, and factor supply levels are combined to create market clearing conditions that determine the equilibrium quantities and prices for the economy in a given time period. This model of the local economy is linked to a population equation for the fish stock, which responds to changes in the level of harvesting pressure in the local economy.

We use this model to simulate the impacts of the 4Ps cash transfer program on households and the local fish stock by exogenously increasing the size of the cash transfer payments to households by 50 percent. An increase in the level of transfer payments allows households to increase their expenditures. The effects ripple through the local economy, affecting nonrecipient households and the demand for various goods and services, including fish. Resultant changes in fish harvesting pressure affect the fish stock size over time, which then feeds back into the local economy by affecting productivity in the fishing sector. This framework allows for an assessment of how cash transfers transmit through households to affect a local natural resource, and how this change to the natural resource affects the welfare of households.

Section 4: Data and Parameter Estimation

The field site for this study is the municipality of El Nido on the island of Palawan in the western Philippines (population 36,000). The data used in this paper come from a series of surveys undertaken in 2015 by the lead author and a team of researchers from the University of California, Davis, and Palawan State University. We implemented three surveys: household surveys, business surveys, and tourist surveys. The household surveys gathered detailed data on assets, time use, net income from all production activities, salaries, expenditures, basic demographic data, and how much they receive annually from the 4Ps cash transfer program. Our definition of a household is a group of people that live in the same home and eat most of their meals together, excluding members who are gone for more than six months of the year. A total of 464 households were surveyed (approx. 6.2 percent of households in El Nido). The business surveys collected detailed information on inputs, factor usage, outputs and revenues for establishments in El Nido. A total of 282 businesses were selected at random from a list of registered businesses obtained from local government officials. The tourist surveys collected data on how much tourists spent at different types of establishments. In total, 433 tourists were surveyed.

The main livelihoods in El Nido are tourism, fishing, farming, and support activities (e.g., retail). The contribution of each sector to total GDP in El Nido can be found in Table 2. Tourism-related sectors constitute the largest contribution to GDP, with hotels and restaurants contributing 35 percent and tourism activities 15 percent. Retail also contributes a large fraction of GDP; a large part of household spending is channeled through small retail stores (Sari-saris), and this sector also provides inputs for other businesses and production activities. Nonretail services (e.g., barbers, mechanics, internet cafes, etc.) create 12 percent of GDP. Fishing (9 percent) and farming (7 percent) contribute smaller shares but are common activities for poor households. In the El Nido economy, agricultural goods and fish can be imported. The shares of imports in total consumption for these two good categories are 0.11 and 0.13, respectively. Other goods and services, such as tourist services (e.g., boat trips), hotel stays, and spending at local retail stores, cannot be imported.

Table 2
GDP (value-added) created by each sector in the El Nido economy.

Sector	*Contribution to GDP in USD (1000's)*	*Sector share of total GDP*
Agricultural goods	2,327	0.07
Fish	3,042	0.09
Hotels/restaurants	11,774	0.35
Retail goods	7,952	0.23
Other services	3,931	0.12
Tourism activities	4,955	0.15
Total	33,979	1.00

Several factors make El Nido an ideal location in which to assess the impact of conditional cash transfers on households and natural resource exploitation. The 4Ps conditional cash transfers program has been active in the municipality since 2009. In addition, many households depend on the local fishery. Approximately 29 percent of households are engaged in fishing, and fish is one of the primary sources of protein for households (see expenditure shares below). The El Nido fishery is an open-access fishery, with few regulations and many fishing agents acting independently, making it vulnerable to overexploitation.

The model aggregates households in El Nido into representative groups based on their participation in the 4Ps program and their engagement in the fishing sector. Summary statistics for the surveyed households in these categories appear in Table 3. The average transfer size for a recipient household is approximately 240USD. The transfers constitute, on average, 11.5 and 8.7 percent of total consumption expenditures for recipient nonfishing and fishing households, respectively. In general, recipient households have lower per capita income net of assistance programs than nonrecipient households. Note, however, that on average recipient households are above the official annual per capita poverty threshold for the province (432.7 USD). The 4Ps program targets households that are below the poverty line, but there are several reasons why recipient households may exhibit higher per capita expenditures. First, the targeting mechanism used by the 4Ps program employs proxy means testing, not direct measurements of per capita consumption expenditures, which could lead to errors in estimates of household expenditures. Second, it may be possible that more than one family unit is living within the same housing unit. In this case, one of the family units may have income below the poverty line and participate in the 4Ps program, while another family in the housing unit may have income above the poverty line and be a non-participant. Our household survey uses a definition of household that would aggregate these two family units together, and this could result in a per capita income for the whole household unit that is above the poverty line. There are some instances in which household units claim levels of 4Ps transfers that are higher than the maximum allotted transfer size of 333USD (17.6 percent of households), which suggests that there are multiple family units within some households that receive 4Ps program transfers.

Table 3
Summary statistics for surveyed households based on 4Ps status and fishing status. All monetary values are given in USD.

Household group (Number of households)	*4Ps transfer size*	*Transfer as percent of household expenditures*	*Average per capita income†*	*Average household size*	*Average children 18 years or younger*	*Average adult education level (years)*
Recipient, nonfishing	239.6	11.5	485.0	6.1	3.1	7.2
(111)	(110.62)	(10.52)	(369.96)	(2.15)	(1.54)	(4.51)
Recipient, fishing	238.2	8.7	535.4	6.1	3.3	5.8
(71)	(113.72)	(5.70)	(343.32)	(1.71)	(1.49)	(3.87)
Nonrecipient, nonfishing	0.0	0.0	792.0	4.1	1.6	8.8
(216)	-	-	(612.42)	(1.80)	(1.32)	(5.07)
Nonrecipient, fishing	0.0	0.0	594.8	4.2	1.6	7.1
(66)	-	-	(329.70)	(2.05)	(1.44)	(4.72)

Standard deviations in parenthesis.
† This per capita income value is net of assistance programs (including 4Ps). The provincial per capita poverty threshold is 432.7 USD.

Recipient households have more children aged 0-18 years old, in line with the program's focus on investing in children's health and education. Recipient households are larger on average than nonrecipient households. There is significant variation within each household group with respect to education level. Fishing households are characterized by lower levels of education, but for households with the same fishing status, recipient households tend to have lower levels of education than nonrecipient households.

Following several previous studies on cash transfer programs using economy-wide modeling techniques, we use regression analysis and data from our field surveys to parameterize the local general equilibrium model (Thome et al., 2013; Filipski et al., 2015). For each household group in the model, detailed consumption data from the household surveys were used to estimate household expenditure shares for the different categories of goods. These expenditure shares were estimated using the following specification:

$$E_{h,i} = \alpha_{h,i} TotalE_h + \mu_{h,i} \qquad (4)$$

where $E_{h,i}$ is the annual expenditure on good i by household h, $\alpha_{h,i}$ are expenditures shares, and $TotalE_h$ is total annual consumption expenditures. The estimated expenditures shares for all household groups (found in Table 4) are used to derive the share parameters for households' CES utility functions. Measures of consumption levels include consumption of food produced by the household itself given that households are implicitly making purchases from themselves when consuming own-produced food. In general, households that are engaged in fishing and households that are poorer spend larger shares of their budgets on direct purchases of fish. For households with the same fishing status, recipients of the 4Ps programs spend a larger share of their budget on fish. For households with the same 4Ps status, fishing households spend a larger share on fish. Among recipients of the 4Ps cash transfers, nonfishing recipients tend to spend relatively more of their budget on agricultural goods. All households spend a large share of their budget on retail goods, but recipient households tend to spend a slightly smaller share than nonrecipient households. Note that retail stores sell many food items, including agricultural goods and fish that were bought directly from producers. Households spend very little on hotels and restaurants given that hotels and restaurants in El Nido target tourists and have high prices. The share of household budgets spent outside of El Nido varies, but for all household groups it is less than 10 percent.

Table 4
Expenditure share estimates for household groups in El Nido.

Household group (observations)	*Agr. goods*	*Fish*	*Retail goods*	*Hotels/ restaur.*	*Other services*	*Outside expend.*
Recipient, nonfishing, 98	0.092**	0.059**	0.47**	0.011*	0.27**	0.099
	(0.02)	(0.01)	(0.07)	(0.01)	(0.08)	(0.06)
Recipient, fishing *68*	0.050**	0.16**	0.47**	0.0026	0.28**	0.042*
	(0.02)	(0.02)	(0.05)	(0.00)	(0.07)	(0.02)
Nonrecipient, nonfishing *195*	0.029**	0.032**	0.53**	0.0063**	0.33**	0.076**
	(0.01)	(0.01)	(0.02)	(0.00)	(0.03)	(0.02)
Nonrecipient, fishing *60*	0.029*	0.13**	0.57**	0.0054	0.24**	0.027**
	(0.01)	(0.03)	(0.05)	(0.00)	(0.05)	(0.01)

Robust standard errors in parentheses. * p < 0.05, ** p < 0.01

The output elasticities for factors of production for production activity i were estimated using

$$\ln(NetRev_i) = \ln(A_i) + \sum_f \beta_{i,f} \ln(FD_{i,f}) + \varepsilon_i. \quad (5)$$

where $NetRev_i$ is annual revenue net of input costs for good i, A_i is a shift parameter, $FD_{i,f}$ is annual factor demand for factor f in the production of good i, and $\beta_{i,f}$ is the elasticity of output with respect to factor f. In instances where it was difficult to obtain reliable measures of factor usage, the assumption of constant returns to scale was used to impute the output elasticity for that factor. To estimate the output elasticity for the fish stock requires time series data that exhibits variation in the fish stock size. Because these data were not available for our field site, the assumption of constant returns to scale was also used to impute the output elasticity for the fish stock by setting $\beta_{stock} = 1 - \sum_f \beta_{fish,f}$.[6] Due to limited data and the inability to assign data from business surveys to household groups, all observations were pooled for the estimations. Therefore, in the model, if multiple households are engaged in a production activity, we assume that each household has the same production technology.

The estimated and imputed output elasticities can be found in Table 5. These coefficients can be interpreted as estimated shares of contribution to value-added for each factor. In agriculture, family labor is associated with a larger share of value-added than hired labor, but land contributes the largest share. In the fishing sector, labor contributes a large share of value-added, with most labor being family labor given that fishing boats are relatively small. The imputed share of value-added contributed by the fish stock is 0.14. For hotels, retail, tourism activities, and other services, capital contributes the largest share to value-added, which likely results from the reliance of these businesses on expensive capital such as buildings, storefronts, and larger tourism boats.

[6] In the regressions, the stock is incorporated into the shift parameter. If the estimated value-added production function is $QVA_{fish} = \hat{A}_{fish} \prod_f FD_{fish,f}^{\hat{\beta}_{fish,f}}$, a new shift parameter, $\tilde{A}_{fish}$, is derived such that $QVA_{fish} = \tilde{A}_{fish} \prod_f FD_{fish,f}^{\hat{\beta}_{fish,f}} * X^{\beta_{stock}}$, meaning that $\hat{A}_{fish} = \tilde{A}_{fish} * X^{\beta_{stock}}$.

Table 5
Output Elasticities for Production Activities in El Nido

	Agriculture & livestock	Fishing	Hotels & restaurants	Retail	Tours	Other services
Family Labor	0.17*	0.52**	0.29**	0.34**	0.14*	0.15
	(0.076)	(0.110)	(0.108)	(0.052)	(0.070)	(0.084)
Hired Labor	0.10**	0.08**	0.20**	0.17**	0.14**	0.17**
	(0.029)	(0.037)	(0.030)	(0.025)	(0.023)	(0.028)
Capital	0.16**	0.26*	0.51†	0.49†	0.72†	0.68†
	(0.046)	(0.089)				
Land	0.53†					
Purchased inputs	0.04					
	(0.038)					
Fish stock		0.14†				
A (shift param.)	7.49**	5.19**	9.50**	8.66**	11.3**	10.10**
	(0.449)	(0.869)	(0.903)	(0.350)	(0.509)	(0.593)
Observations	144	132	88	155	73	95

Robust standard errors in parentheses. †These elasticities are imputed and not estimated.
* $p < 0.05$, ** $p < 0.01$

For parameters that could not be estimated, values are drawn from the literature and relevant contextual information collected at the field site. The two goods that are tradable in El Nido are agricultural goods and fish. The elasticity between an imported good and locally produced good of the same type is the Armington elasticity. This elasticity determines how substitutable the two are in the eyes of those demanding the goods. Choosing the elasticity of substitution between goods imported from surrounding areas and goods produced within the municipality is particularly challenging due to the small geographic focus of the model. Armington elasticity values that exist in the literature are typically at the scale of a country or large geographic region, rather than a village or small municipality. At the country level, there is likely less substitutability between locally produced goods and goods imported from other countries. For example, fish imported from other countries are more likely to be of different species than those caught within the country and may also vary in processing procedures (e.g., frozen versus fresh). However in the case of El Nido, the fish being imported into the municipality are primarily the same species that are caught locally. Imported fish are caught in a large fish producing region south of El Nido on the same island (Liminangcong, Taytay). Furthermore, the traders interviewed reported importing fresh fish, not frozen fish. The substitutability between imported and locally produced agricultural goods is likely similar. The staple crop in El Nido is rice, and the rice imported into El Nido comes from rice producing regions on the same island. As a result, we use Armington elasticities that are higher than those reported in the literature for country-scale models. In the literature, values reported for fish range from 0.82 to 2.8, and values for agricultural goods range from 1.03 to 6 (Annabi et al., 2006; Hertel, 1997). We set the Armington elasticities at a value of 8 for both of these good types and, given the uncertainty about the true parameter values, examine a range of different elasticities of substitution to explore how results change under different assumptions. This also provides an opportunity to examine how localities with different local trade scenarios may vary in how they are affected by tourism expansion.

Many CGE models assume that household demand follows a linear expenditure system, which assumes that all cross-prices elasticities are zero. However, in this model households are low income households that are spending a substantial portion of their income on food, and calories can be obtained from multiple good categories (e.g., agricultural goods, fish, and retail products such as canned goods). As a result, it is likely that households' preferences are characterized by greater substitutability across categories of goods from which they can obtain calories. As a result we model household demand as deriving from CES utility with an elasticity of substitution greater than unity, which allows households to substitute away from sources of food if they become relatively more expensive. The exact elasticity of substitution is not known, so a value of 3 is used and a sensitivity analysis is performed to explore how results change under different specifications. Tourists are also assumed to have a high level of substitutability given that their purchases are of non-essential items such as boat tours. The elasticity of substitution in consumption for tourists is also set to 3 and included in the sensitivity analysis.

In the biological system, the initial stock size is set at 36 percent of carrying capacity, which is based on ongoing ecological surveys in the El Nido region (Alice Rogers, personal communication, Aug 30, 2016) and on fisheries literature that shows that nearshore fish stocks in developing countries tend to be characterized by high levels of exploitation and low biomass (Worm, 2009; Kellner et al., 2011). Given the challenge of estimating an intrinsic growth rate for an aggregate fish stock, the growth rate is assumed to be 0.50 and a sensitivity analysis is performed.

The search cost function (Equation 2) determines how input costs for fishing increase as the size of the fish stock decreases. These changes could results from factors such as the depletion of fish species or life cycle stages that are less costly to catch. This function is calibrated to reproduce the level of input costs measured in the household surveys by calibrating the parameter a to a value that reproduces the baseline intermediate demand shares for fishing. Given that the rate at which input costs increase as the fish stock declines cannot be estimated without observed variation in the fish stock size, the parameter n is set to the value of 2 and a sensitivity analysis is provided.

Section 5: Results

Using the bioeconomic general equilibrium framework developed above, we simulate the impact of a 50 percent increase in the size of the 4Ps cash transfers on households and the fish stock, holding the transfer size at this level for 10 years. The results are first presented for the estimated and preferred chosen parameter values. This is followed by sensitivity analyses for the Armington elasticities, labor supply elasticities, elasticity of substitution in consumption, the fishing search cost parameter, and the fish intrinsic growth rate.

5.1: Preferred Parameter Set

Table 6 shows the impact the 50 percent increase in cash transfer payments has on fish biomass and local economic variables in year 1 and year 10. The gray column represents the preferred parameter set. In the model, the change in fish harvest levels in the current year does not affect the fish stock size until the following year. Therefore, the local economic impacts in year 1 can be interpreted as the impacts of the increase in cash transfer payments that would accrue if one ignored the biological feedback through the fish population. In contrast, in following years, the change in fish resources affects the local economy by affecting the productivity of fishers. We can see these impacts in the results presented for year 10. A comparison of Year 1 and Year 10 shows how linking a dynamic model of the natural resource stock to the local CGE model more accurately simulates the impacts of a cash transfer program by accounting for environmental impacts and how they affect household incomes and the rest of the local economy.

The increase in the size of cash transfer payments to recipient households increases the beneficiaries' consumption levels, which results in a higher demand for locally produced and imported fish. The increase in demand for locally produced fish stimulates production in the fishing sector in year 1which results in higher harvest levels. However, the elevated harvesting pressure results in a decline in the fish stock over time. This is illustrated by the bold black line in Figure 1, which plots the percentage change in the fish stock relative to the initial stock size. This represents an important environmental spillover of the cash transfer program.

Table 6
Simulation results for a 50 percent increase in the size of the 4Ps cash transfers for different Armington elasticities for agricultural goods and fish. The values represent percentage changes from baseline levels. Results are presented for year 1 and year 10 of the simulation. Note that the results in year 1 represent the impact of the shock on the local economy prior to any changes in the fish stock size.

Armington Elasticities	200		20		8 (Preferred)		2	
Variable	*Year 1*	*Year 10*	*Year 1*	*Year 10*	*Year 1*	*Year 10*	*Year 1*	*Year 10*
Fish biomass	0.0	0.0	0.0	-1.8	0.0	-3.5	0.0	-5.8
Real income								
Recipient Fishing	3.4	3.4	3.7	3.1	3.9	2.8	4.2	2.6
Recipient Nonfishing	4.6	4.6	4.8	4.6	4.9	4.7	5.1	4.8
Nonrecip. Fishing	0.0	0.0	1.0	-0.4	1.7	-0.5	2.4	-0.5
Nonrecip. Nonfishing	1.4	1.4	1.8	1.6	2.1	1.8	2.4	2.1
Nonresident	0.0	0.0	-0.1	-0.1	-0.1	-0.2	-0.2	-0.3
Prices								
Agricultural goods	0.1	0.1	0.8	0.7	1.2	1.2	1.8	1.8
Fish	0.1	0.1	0.6	0.9	0.9	1.8	1.3	3.2
Hotels/restaurants	0.1	0.1	0.2	0.2	0.2	0.2	0.3	0.3
Retail goods	0.5	0.5	0.6	0.6	0.7	0.7	0.8	1.0
Other services	0.7	0.7	0.9	0.8	1.1	1.0	1.2	1.2
Tourism activities	0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.2
Aggregate production								
Agricultural goods	0.0	0.0	0.3	0.3	0.6	0.5	0.8	0.8
Fish	0.0	0.0	0.9	-0.5	1.5	-0.7	2.2	-0.9
Hotels/restaurants	0.0	0.0	-0.1	-0.1	-0.1	-0.1	-0.1	-0.2
Retail goods	1.3	1.3	1.7	1.6	1.9	1.8	2.2	2.2
Other services	0.5	0.5	0.6	0.6	0.7	0.6	0.8	0.8
Tourism activities	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Imports								
Agricultural goods	24.0	24.0	16.7	15.6	11.0	10.4	4.4	4.5
Fish	20.8	20.8	13.8	18.7	9.4	14.4	4.8	5.7
Nominal GDP	0.8	0.8	1.2	0.9	1.5	1.1	1.8	1.4

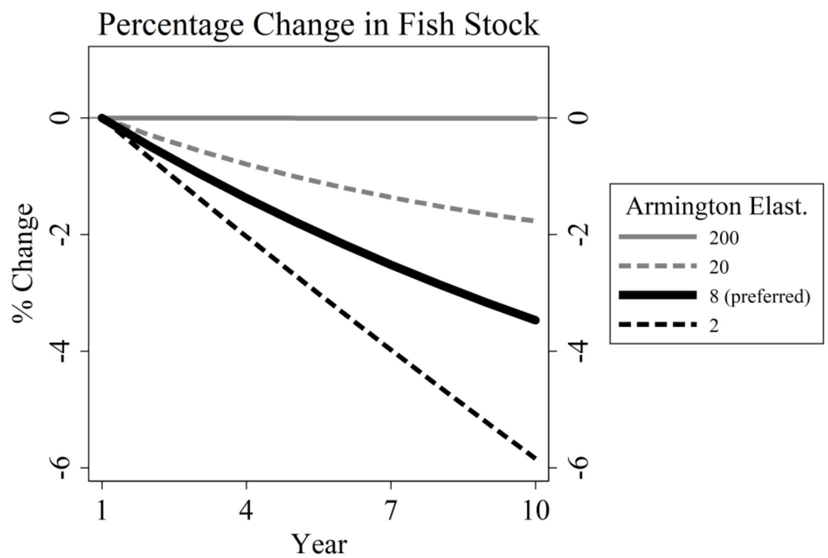

Figure 1: Percentage changes in fish stock size as a result of the 50 percent increase in the size of the 4Ps cash transfer payments. These changes are relative to the baseline stock size and are shown for four different values of the Armington elasticities of substitution for agricultural goods and fish. The thick black line corresponds to the preferred value for the Armington elasticities.

In year one, all resident households benefit from the cash transfer program. Recipient households experience the largest percentage change in their real incomes given that they are directly receiving transfers from the 4Ps program. When recipient households spend their transfers at local businesses owned by nonrecipient households, this creates positive economic spillovers for the nonrecipients. While both nonrecipient households benefit from the spillovers, the nonfishing nonrecipient households benefit more because they have higher levels of capital ownership in a variety of businesses patronized by recipient households (e.g., retail stores). Nonresidents primarily own hotels that are for tourists, and because resident households do not spend money at these establishments, nonresidents businesses receive little impact. They experience a small decline in real income as a result of higher input costs for their businesses (due to local price inflation).

All resident households are negatively impacted by the decline in the fish stock (Figure 2, Panel C). Fishing households are net sellers of fish and therefore receive a disproportionate impact. This means that the impacts of the program will be heterogeneous across participating households due to the welfare consequences of environmental impacts. The impacts on nonrecipient households are also heterogeneous. Nonrecipient fishing households experience a decline in real income to a level below their initial value by the end of the 10 years. This suggests that for the nonrecipient fishing households that are closely linked to the natural resource, the initial gains as a result of the economic spillovers of cash transfer program may eventually be eroded by negative local economic consequences of the program's environmental impacts. Nonfishing households also experienced declines in their real incomes as a result of the decline in the fish population, but the impact on these households is smaller because they are affected indirectly through prices and diminished spending by fishing households.

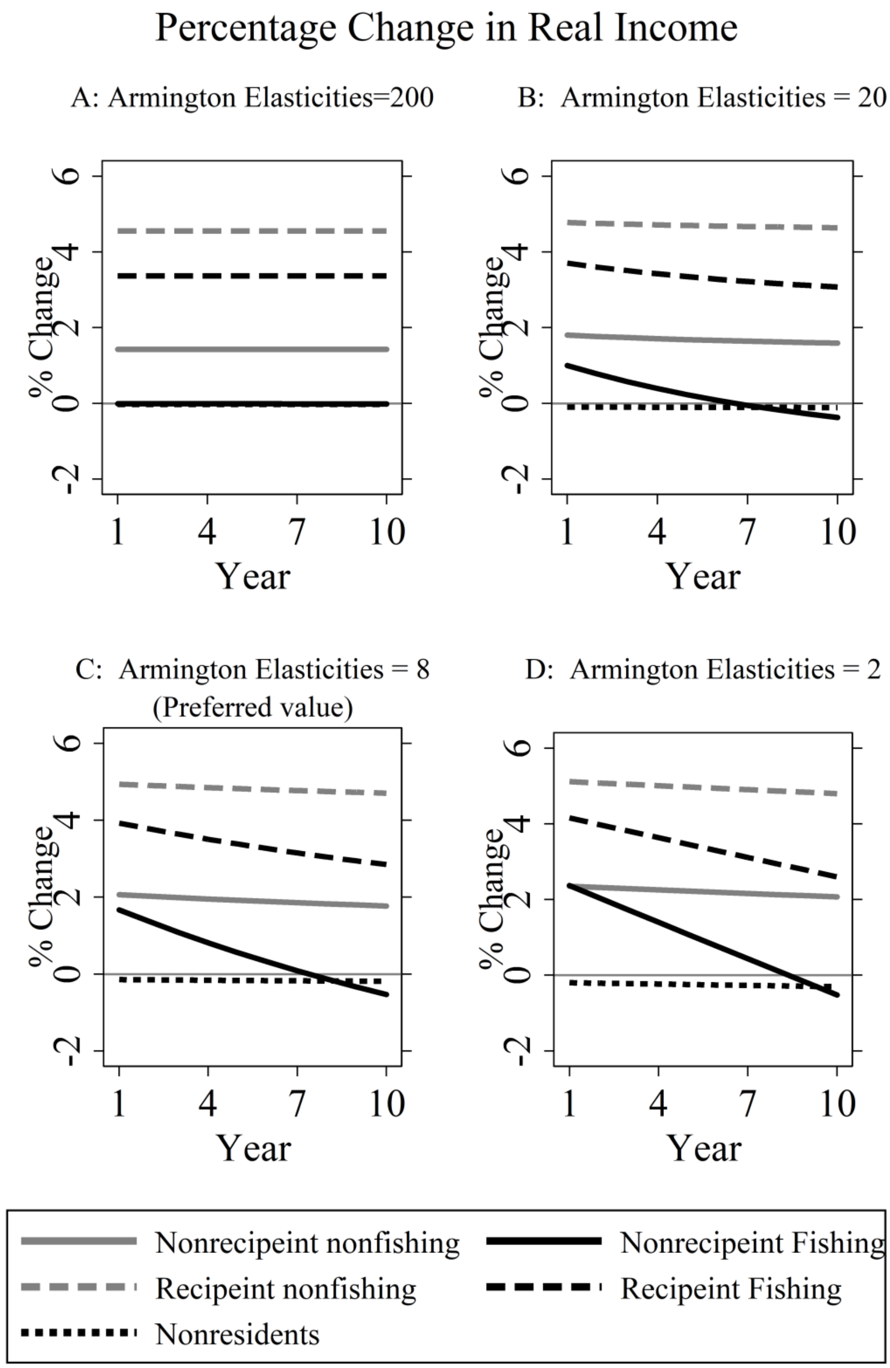

Figure 2: Percentage changes in real incomes for household groups and nonresidents as a result of the 50 percent increase in the size of the 4Ps cash transfer payments. These changes are relative to baseline income levels and are shown for four different values of the Armington elasticities of substitution for agricultural goods and fish. Panel C represents the preferred value for these Armington elasticities.

Table 7 provides information about the dollar value of the impacts on households by calculating the present value of the cash transfer shock for the 10 year period. This is calculated as the present value of a household's real income stream with the increase in transfer size minus the present value of a household's real income stream without the increase in transfer size. This present value is calculated for two different model specifications, the bioeconomic general equilibrium model developed in Section 3 and a static general equilibrium model. The static model is the same as the bioeconomic general equilibrium model except that the fish stock size is held fixed. Presenting the results for both of these models helps illustrate the value of accounting for the dynamic natural resource stock. The columns labeled Δ represent the difference between the bioeconomic and static models. The gray column represents the preferred parameter set.

The recipient households that receive direct payments benefit the most from the 4Ps program. However the nonrecipient households also benefit as a result of economic spillovers. The nonrecipient nonfishing households received relatively more benefits in the form of economic spillovers given that they own more capital in sectors that recipient households patronize. Nonrecipient fishing households primarily own capital related to fishing and agriculture, and as a result receive less spillover benefits. Note that the negative consequences of the fish stock decline are felt in the future. Therefore, it is possible that if a timeframe longer than 10 years were considered, the nonrecipient fishing households may receive a present value of future income below their baseline levels. The static model that does not account for the decline in the fish stock overestimates the income benefits of the cash transfer program. The biggest discrepancies between the bioeconomic and static models are for the fishing households that depend more closely on the natural resource.

Table 7
Change in present value of per capita income for a ten year period as a result of the 50 percent increase in the 4Ps cash transfer payments for two model specifications. The bioeconomic CGE model (B) is the full model described in Section 3, which includes a dynamic fish stock that responds to harvest. The static CGE (S) model assumes the fish stock is fixed. The difference between model B and model S is denoted B-S=Δ. The static model tends to overestimate the benefits of the cash transfers because it ignores the deleterious effects of the fish stock decline. All results are in US dollars.

Armington Elasticity	200			20			8 *(Preferred)*			2		
Model: *Bioeconomic CGE (B)* *Static CGE (S)* *Difference (B-S=Δ)*	*B*	*S*	Δ	*B*	*S*	Δ	*B*	*S*	Δ	*B*	*S*	Δ
Household												
Recipient Fishing	168	168	0	167	184	-17	167	195	-28	168	207	-39
Recipient Nonfishing	211	211	0	218	221	-3	223	229	-6	230	237	-7
Nonrecip. Fishing	-1	0	-1	11	50	-39	25	83	-58	46	118	-72
Nonrecip. Nonfishing	97	97	0	115	123	-8	130	141	-11	151	160	-9

The discount rate used is 0.05. Values are expressed in per capita terms.

5.2: Alternative Values for the Armington Trade Elasticity

Trade of agricultural goods and fish in the model is influenced by Armington elasticities, which determine the degree of substitutability between imported and locally produced goods. The preferred parameter set uses relatively high elasticities given that most imports come from the surrounding region and are likely close substitutes for locally produced goods. However, it is valuable to explore other possible values of the Armington trade elasticities in order to assess how cash transfer programs may impact natural resources and local economies differently under different trade scenarios. In each case examined, the baseline economy is the same in terms of consumption levels, production levels, incomes, etc. The impact of the different trade elasticities manifests in how the economy deviates from this baseline economy in response to the increase in the size of the cash transfer payments.

Results of the increase in cash transfer size under different assumptions about the Armington trade elasticities for fish and agricultural goods are presented in Table 6. Features of a local economy that facilitate the availability of fresh imports that are close substitutes for local goods (such as better roads and trade relationships with outside producers) likely would affect trade of both fish and agricultural goods. Therefore, in each simulation presented, the Armington trade elasticities were changed for both goods. When the trade elasticities are lower, meaning imports are less substitutable with locally produced goods, this leads to lower demand for imports, higher demand for locally produced goods, higher local prices, and increased initial output of locally produced goods. In the fishing sector, this causes higher harvesting pressure and a larger decline in the local fish population (Figure 1). Alternatively, if close substitutes are available, additional demand created by the cash transfer program is met entirely via imports, resulting in almost no decline in the local fish stock. Overall consumption of fish is higher, but some of the fishing pressure is "exported" to other regions. These results suggest that when close substitutes cannot be imported, cash transfer programs may have larger negative impacts on local natural resource stocks.

The impacts that cash transfers have on households' real incomes also depend on the degree of substitutability between imported and locally produced goods (Table 6). If imports are not close substitutes, then a greater share of the additional demand created by the cash transfers is met by local production. This causes less leakage out of the local economy, which results in greater local economic stimulus and higher initial real income gains for resident households. This is particularly true for the nonrecipient fishing households that specialize in fishing and only receive benefits from the cash transfer program via economic spillovers. Nonresidents, on the other hand, are slightly worse off. They only own businesses that target tourists (not local residents), and these businesses face higher input costs when there is greater stimulation of the local economy. Alternatively, if imports are close substitutes, reliance on imports creates more leakage out of the local economy and lower initial real income gains for resident households.

While initial real incomes gains are higher for resident households when there is less reliance on imports, a larger associated decline in the fish stock results in greater erosion of these income gains, particularly for fishing households (Figure 2). This suggests that meeting demand stimulated by cash transfer programs through imports is associated with trade-offs. Less reliance on imports is worse for local natural resource stocks, but also results in greater local economic stimulus that benefits resident households. The net effect in the case of El Nido can be seen by examining the present value of households' real incomes over the 10 year period (*B* columns in Table 7). Although the fish stock declines more when there are fewer imports, households are still better off than when there are more imports. Larger initial gains in real incomes due to greater local economic stimulus more than compensate for the decline in natural resources.[7]

When close substitutes for local fish are not available, the discrepancies between the static and bioeconomic models are larger (Δ columns in Table 7). The inability to import close substitutes for local fish results in greater additional local fishing pressure and a larger decline in the fish stock. This suggests that accounting for dynamic natural resource stocks when conducting impact evaluations is most critical when close substitutes for the local natural resource are not available.

[7] Note however that this result depends on factors such as the length of time considered and the discount rate.

5.3: Sensitivity Analyses

5.3.1: Sensitivity Analysis for Elasticities of Substitution in Consumption:

Given that other foods may serve as substitutes for fish, we now consider how these results may vary for different values of the elasticity of substitution in consumption (Table 8). Given that tourists also purchase some fish directly (as opposed to indirectly through restaurants), the elasticity of substitution in consumption changes both for households and for tourists in this sensitivity analysis. The qualitative impacts of the cash transfer program are robust to different values of the elasticity of substitution. In each case, the increase in the size of the cash transfer payments causes higher demand for locally caught fish and a decline in the local fish stock. As the fish stock declines, the relative price of fish increases, causing households to substitute away from fish. When the elasticity of substitution in consumption is larger, households substitute away from fish more and the fish stock declines less, though the difference in fish stock decline is small. While more substitutability between consumption goods reduces environmental impacts, it also results in households shifting more of their spending outside of the local economy. This results in slightly lower overall real incomes for most resident households due to the smaller stimulus to the local economy.

Table 8
Simulation results for a 50 percent increase in the size of the 4Ps cash transfers for different elasticities of substitution in consumption in the utility functions of households and tourists. The values represent percentage changes from baseline levels.

Elasticity of substitution in consumption	4		3 (*Preferred*)		2	
Variable	*Year 1*	*Year 10*	*Year 1*	*Year 10*	*Year 1*	*Year 10*
Fish biomass	0.0	-3.2	0.0	-3.5	0.0	-3.8
Real income						
Recipient Fishing	3.9	2.9	3.9	2.8	3.9	2.8
Recipient Nonfishing	4.9	4.7	4.9	4.7	5.0	4.7
Nonrecip. Fishing	1.6	-0.5	1.7	-0.5	1.7	-0.5
Nonrecip. Nonfishing	2.0	1.8	2.1	1.8	2.2	1.8
Nonresident	-0.1	-0.1	-0.1	-0.2	-0.3	-0.3
Prices						
Agricultural goods	1.1	1.1	1.2	1.2	1.4	1.2
Fish	0.9	1.6	0.9	1.8	1.0	2.0
Hotels/restaurants	0.2	0.2	0.2	0.2	0.2	0.2
Retail goods	0.7	0.7	0.7	0.7	0.8	0.8
Other services	0.9	0.9	1.1	1.0	1.2	1.1
Tourism activities	0.2	0.2	0.2	0.2	0.2	0.1
Aggregate production						
Agricultural goods	0.5	0.5	0.6	0.5	0.6	0.6
Fish	1.5	-0.7	1.5	-0.7	1.6	-0.7
Hotels/restaurants	0.0	-0.1	-0.1	-0.1	-0.1	-0.1
Retail goods	1.9	1.8	1.9	1.8	2.0	1.8
Other services	0.6	0.6	0.7	0.6	0.9	0.8
Tourism activities	0.0	0.0	0.0	0.0	0.0	0.0
Imports						
Agricultural goods	10.1	9.7	11.0	10.4	12.1	11.1
Fish	9.1	12.9	9.4	14.4	9.8	16.2
Nominal GDP	1.4	1.1	1.5	1.1	1.5	1.1

5.3.2: Sensitivity Analysis for Elasticities of Labor Supply for Hired and Family Labor:

The labor supply elasticity is relatively high in the preferred model given that there are high levels of unemployment in El Nido. Table 9 presents the model results for the preferred parameter set along with different values for labor supply elasticities to examine the sensitivity of model results to this parameter value. For labor supply elasticities that remain relatively elastic, model results do not change substantively. As the labor supply becomes more inelastic there is a smaller decline in the fish stock. This results from the fact that a more inelastic labor supply causes higher inflationary pressures and a smaller production response in the fishing sector. In general, the real incomes of households do not change significantly because incomes depend on the total size of payments to household factors. When labor supply responses from households are smaller, a higher wage is paid to this smaller labor supply, which results in similar household real incomes. However greater price inflation when labor supply is more inelastic results in slightly lower real incomes for resident households. Large deviations from these results are not expected unless there is an inelastic labor supply, which is unlikely to be the case in El Nido due to high unemployment.

Table 9
Simulation results for a 50 percent increase in the size of the 4Ps cash transfers for different labor supply elasticities for hired labor and family labor. The values represent percentage changes from baseline levels.

Labor supply elasticities	100 (*Preferred*)		10		5	
Variable	*Year 1*	*Year 10*	*Year 1*	*Year 10*	*Year 1*	*Year 10*
Fish biomass	0.0	-3.5	0.0	-3.3	0.0	-3.1
Real income						
Recipient Fishing	3.9	2.8	3.9	2.9	3.8	2.9
Recipient Nonfishing	4.9	4.7	4.9	4.7	4.9	4.7
Nonrecip. Fishing	1.7	-0.5	1.6	-0.4	1.5	-0.3
Nonrecip. Nonfishing	2.1	1.8	2.0	1.8	2.0	1.8
Nonresident	-0.1	-0.2	-0.1	-0.1	-0.1	-0.1
Prices						
Agricultural goods	1.2	1.2	1.3	1.2	1.3	1.2
Fish	0.9	1.8	1.0	1.8	1.1	1.7
Hotels/restaurants	0.2	0.2	0.3	0.3	0.3	0.3
Retail goods	0.7	0.7	0.8	0.8	0.8	0.8
Other services	1.1	1.0	1.1	1.0	1.2	1.1
Tourism activities	0.2	0.2	0.2	0.2	0.3	0.2
Aggregate production						
Agricultural goods	0.6	0.5	0.5	0.5	0.5	0.5
Fish	1.5	-0.7	1.4	-0.6	1.2	-0.5
Hotels/restaurants	-0.1	-0.1	-0.1	-0.1	-0.2	-0.2
Retail goods	1.9	1.8	1.9	1.8	1.8	1.7
Other services	0.7	0.6	0.7	0.6	0.7	0.6
Tourism activities	0.0	0.0	0.0	0.0	0.0	0.0
Imports						
Agricultural goods	11.0	10.4	11.3	10.6	11.5	10.9
Fish	9.4	14.4	9.9	14.2	10.4	14.1
Nominal GDP	1.5	1.1	1.5	1.1	1.5	1.2

5.3.3: Sensitivity Analysis for Fishing Search Cost:

As the fish stock declines, the model assumes that the costs of fishing increase as a result of a need for greater expenditures on fuel while searching for fish and visiting more distant fishing spots. While the parameter a in the search cost function (Equation 2) is calibrated with household survey data, the relationship that determines how costs change as the fish stock changes is unknown. To address this uncertainty, Table 10 provides a sensitivity analysis for the parameter n. If search costs rise more quickly as the fish stock declines (a larger n), this results in a smaller fish stock decline. Fishing households are slightly worse off when cost rise more quickly as the fish stock declines, even though they benefit from a relatively higher stock level. However, changes to real incomes are small.

Table 10
Simulation results for a 50 percent increase in the size of the 4Ps cash transfers for different values of the parameter *n* in the search cost function. The values represent percentage changes from baseline levels.

Search cost parameter (n)	2.5		2 (*Preferred*)		1.5	
Variable	*Year 1*	*Year 10*	*Year 1*	*Year 10*	*Year 1*	*Year 10*
Fish biomass	0.0	-3.0	0.0	-3.5	0.0	-4.0
Real income						
Recipient Fishing	3.9	2.8	3.9	2.8	3.9	2.9
Recipient Nonfishing	4.9	4.7	4.9	4.7	4.9	4.7
Nonrecip. Fishing	1.7	-0.7	1.7	-0.5	1.7	-0.3
Nonrecip. Nonfishing	2.1	1.8	2.1	1.8	2.1	1.8
Nonresident	-0.1	-0.2	-0.1	-0.2	-0.1	-0.2
Prices						
Agricultural goods	1.2	1.2	1.2	1.2	1.2	1.2
Fish	0.9	1.8	0.9	1.8	0.9	1.7
Hotels/restaurants	0.2	0.2	0.2	0.2	0.2	0.2
Retail goods	0.7	0.7	0.7	0.7	0.7	0.7
Other services	1.1	1.0	1.1	1.0	1.1	1.0
Tourism activities	0.2	0.2	0.2	0.2	0.2	0.2
Aggregate production						
Agricultural goods	0.6	0.5	0.6	0.5	0.6	0.5
Fish	1.5	-0.8	1.5	-0.7	1.5	-0.6
Hotels/restaurants	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1
Retail goods	1.9	1.8	1.9	1.8	1.9	1.8
Other services	0.7	0.6	0.7	0.6	0.7	0.7
Tourism activities	0.0	0.0	0.0	0.0	0.0	0.0
Imports						
Agricultural goods	11.0	10.3	11.0	10.4	11.0	10.4
Fish	9.4	14.5	9.4	14.4	9.4	14.2
Nominal GDP	1.5	1.1	1.5	1.1	1.5	1.1

5.3.4: Sensitivity Analysis for the Fish Intrinsic Growth Rate:

The model assumes that the bioeconomic system is at a steady state in the baseline by calibrating a carrying capacity level and initial stock size such that initial growth in the fish population is equal to initial fish harvest. This means that the initial stock size (assumed to be 36 percent of carrying capacity) depends on the size of the chosen fish growth rate. Therefore, the results in Table 11 assess model results for different growth rate-initial stock size pairs.

The qualitative results of the increase in cash transfers are robust to different assumptions about the fish growth rate. In each case the shock to cash transfers causes an increase in the demand for local fish and a decrease in the fish stock size. However when the fish growth rate is higher, and the initial stock size smaller, the increase in demand for local fish causes a larger percentage decrease in the fish stock. This results in a larger decrease in production in the fishing sector, which leaves fishing households relatively worse off. Nonfishing households experience only minimal effects.

Table 11
Simulation results for a 50 percent increase in the size of the 4Ps cash transfers for different values of the fish intrinsic growth rate. The values represent percentage changes from baseline levels.

Intrinsic growth rate	0.6		0.5 (*Preferred*)		0.4	
Variable	*Year 1*	*Year 10*	*Year 1*	*Year 10*	*Year 1*	*Year 10*
Fish biomass	0.0	-4.0	0.0	-3.5	0.0	-2.9
Real income						
Recipient Fishing	3.9	2.7	3.9	2.8	3.9	3.0
Recipient Nonfishing	4.9	4.7	4.9	4.7	4.9	4.7
Nonrecip. Fishing	1.7	-0.9	1.7	-0.5	1.7	-0.2
Nonrecip. Nonfishing	2.1	1.7	2.1	1.8	2.1	1.8
Nonresident	-0.1	-0.2	-0.1	-0.2	-0.1	-0.2
Prices						
Agricultural goods	1.2	1.2	1.2	1.2	1.2	1.2
Fish	0.9	1.9	0.9	1.8	0.9	1.6
Hotels/restaurants	0.2	0.2	0.2	0.2	0.2	0.2
Retail goods	0.7	0.7	0.7	0.7	0.7	0.7
Other services	1.1	1.0	1.1	1.0	1.1	1.0
Tourism activities	0.2	0.2	0.2	0.2	0.2	0.2
Aggregate production						
Agricultural goods	0.6	0.5	0.6	0.5	0.6	0.5
Fish	1.5	-1.1	1.5	-0.7	1.5	-0.3
Hotels/restaurants	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1
Retail goods	1.9	1.8	1.9	1.8	1.9	1.8
Other services	0.7	0.6	0.7	0.6	0.7	0.7
Tourism activities	0.0	0.0	0.0	0.0	0.0	0.0
Imports						
Agricultural goods	11.0	10.3	11.0	10.4	11.0	10.5
Fish	9.4	15.1	9.4	14.4	9.4	13.5
Nominal GDP	1.5	1.0	1.5	1.1	1.5	1.2

Section 6: Conclusions

This study highlights the importance of accounting for both local economic and local environmental impacts of cash transfer programs. Our findings are consistent with other recent work on cash transfers, but also make an important addition to this literature. Recent work using economy-wide modeling has shown that impact evaluation efforts need to account for the economic spillovers of cash transfer programs (Filipski et al., 2015; Thome et al., 2013). These spillovers affect both recipient and nonrecipient households, and may stimulate local production. Other work has shown that cash transfers may have environmental impacts. Alix-Garcia et al. (2013) found that the OPORTUNIDADES cash transfer program in Mexico caused elevated levels of deforestation. We build on these previous studies by developing a bioeconomic local general equilibrium model that accounts for economic spillovers, environmental impacts, and the consequence environmental impacts have for the local economy. This provides a more accurate assessment of the impacts of cash transfer programs by accounting for how environmental impacts change welfare outcomes for all households.

We applied our model to a municipality in the western Philippines where the *Pantawid Pamilyang Pilipino Program* (4Ps) cash transfer program is implemented. The environmental impacts of cash transfer programs appear to have important consequences for local economies and household welfares. All households are initially better off because of the program, either through direct transfers to beneficiaries or via economic spillovers to beneficiaries as well as nonbeneficiaries. However, a decline in the local fish stock triggered by the cash transfer program negatively affects all households' real incomes in this fishing community. For both recipients and nonrecipients, the biggest declines are felt by those directly engaged in production activities in the fishing sector, which is an important source of heterogeneity vis-à-vis the outcomes of the cash transfer program. For example, nonrecipient households both initially experience real incomes higher than their baseline value, but fishing households eventually suffer from real incomes below their baseline level due to a declining fish stock. These results suggest the potential need for complementing cash transfer programs with interventions that can improve management of local natural resources.

We found trade to be an important mediating factor for the environmental consequences of cash transfer programs. If it is not possible to import close substitutes for a local natural resource, cash transfer programs will likely have a larger impact on the natural resource stock. Alternatively, if close substitutes can be imported, this limits the environmental impact. However, greater reliance on imports results in more leakage of money out of the local economy, which results in fewer income spillovers and lower real incomes for households. This suggests that while trade may alleviate local environmental consequences of a cash transfer program, it is associated with tradeoffs between reducing environmental impacts and improving local welfare.

These findings on how local natural resources are affected and the role that trade plays are consistent with other results in the literature. Alix-Garcia et al. (2013) show that deforestation as a result of the OPORTUNIDADES program was strongest in areas with poor transportation infrastructure (a proxy for trade). Research in the international trade literature has shown that, in general, access to trade may decrease pressure on an unmanaged local natural resource when the local economy imports the natural resource, but may increase pressure if the local economy exports the resource (Chichilnisky, 1994; Brander and Taylor, 1997; Brander and Taylor 1998).

Since El Nido imports fish, trade can help diminish the local environmental impacts of the cash transfer program by allowing for the substitution of imports for local fish. An important question that is beyond the scope of this study is whether better access to trade would create a baseline economy that is more or less vulnerable to negative environmental impacts. Cinner et al. (2012) found that coral reef fisheries that were closer to markets tended to have lower fish biomass, suggesting that market access may contribute to overfishing. In this sense, important variables such as the initial stock size may depend on whether or not the location engages in trade. In this study, each trade scenario examined (i.e., different Armington elasticities) is calibrated to the same baseline economic data from our surveys; the different trade scenarios only differ in how the increase in cash transfers causes the local economy to deviate from that baseline. Future work would benefit from assessing the impact of both shocks to the economy (gaining access to trade and a cash transfers program) in order to assess the net impact of the two.

Cash transfer programs are now one of the primary tools being used by governments and poverty relief efforts to combat poverty. This paper highlights a new approach for undertaking impact evaluations of these programs. The poor households targeted by cash transfer programs are connected to other agents in the local economy through economic linkages. This requires modeling linkages such as labor markets and market for consumption goods using a local general equilibrium framework. However, households are also affected by changes to local natural resources because they depend on these resources for food and income. As a result, assessing the impacts of cash transfer programs requires an integrated approach such as the bioeconomic local general equilibrium framework developed in this paper. This framework can help researchers and policymakers more accurately assess the impacts of cash transfer programs and assess potential tradeoffs between their economic and environmental consequences.

APPENDIX 1

Table A1
Index, Variable, and Parameter Definitions

Index, Variable, or Parameter	*Definition*
i	Production sector
f	Factor
h	Household type
t	Time step (one year)
$Y_{i,t}$	Output in sector *i* at time *t*
$FD_{i,f,t}$	Factor demand for factor *f* in production of good *i* at time *t*
$FVA_{f,t}$	Factor value added for factor *f* at time *t*
$TFI_{h,t}$	Total factor income at time *t*
$P_{i,t}$	Equilibrium price for good *i* at time *t*
$PVA_{i,t}$	Price value added for good *i* at time *t*
$W_{i,t}$	Wage for factor *f* at time *t*
$I_{h,t}$	Income for household *h* at time *t*
$IBAR_{h}$	Exogenous income for household *h*
$CD_{h,i,t}$	Consumption demand by household *h* for good *i* at time *t*
$ED_{i,t}$	Aggregate demand in El Nido for good *i* at time *t*
$MS_{i,t}$	Marketed surplus for good *i* at time *t*
$IN_{i,t}$	Intermediate demand for good *i* at time *t*
$FS_{f,t}$	Total factor supply for factor *f* at time *t*
A_i	Cobb-Douglas shift parameter
$\beta_{i,f}$	Output elasticity for factor *f* for good *i*
$\alpha_{h,i}$	Expenditure Share for household *h* for good *i*
TTE	Total tourist expenditures
$TD_{i,t}$	Tourist demand for good *i*
$QQ_{i,t}$	Armington composite of good type *i*
$QD_{i,t}$	Locally produced quantity good type *i*
$QM_{i,t}$	Imported quantity good type *i*
γ	Intrinsic growth rate for fish stock
K	Carrying capacity for fish population

Table A2
Core Economic Equations of the Local CGE Model of El Nido

Relation	*Equation*
Production functions	$Y_{i,t} = Y_i(FD_{i,f,t})\ i = 1, \dots, I; f = 1, \dots, F$
Intermediate demands	$IN_{i,t} = IN_i(Y_{i,t})\ i = 1, \dots, I$
Factor demand	$FD_{i,f,t} = FD_{i,f}(Y_{i,f}, PVA_{i,t}, W_{i,t})\ i = 1, \dots, I; f = 1, \dots, F$
Total factor demand	$TFD_{f,t} = \sum_i (FD_{i,f,t})\ i = 1, \dots, I; f = 1, \dots, F$
Factor value added	$FVA_{f,t} = \sum_i (FD_{i,f,t} W_{i,t})\ i = 1, \dots, I; f = 1, \dots, F$
Total Factor Income	$TFI_{h,t} = TFI_h(FVA_{f,t})\ h = 1, \dots, H$
Household total income	$I_{h,t} = TFI_{h,t} + IBAR_h\ \ h = 1, \dots, H$
Household consumption demand	$CD_{h,i,t} = CD_{h,i}(P_{i,t}, I_{h,t}) i = 1, \dots, I; h = 1, \dots, H$
Tourist demand	$TD_{i,t} = TD_i(P_{i,t}, TTE)\ i = 1, \dots, I$
El Nido demand	$ED_{i,t} = IN_{i,t} + \sum_h (CD_{h,i,t}) + TD_{i,t}\ \ i = 1, \dots, I$
Armington composite goods	$QQ_{i,t} = QQ_i(QM_{i,t}, QD_{i,t})$ (*imported goods only*)
Product market equilibrium	$MS_{i,t} = Y_{i,t} - ED_{i,t}\ i = 1, \dots, I$
Factor market equilibrium	$TFD_{f,t} = FS_{f,t}\ \ f = 1, \dots, F$

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