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Shocks, social protection, and resilience: Evidence from Ethiopia

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ABSTRACT

The malign effect of shocks has long been a concern within economics, partly because they result in transitory welfare losses and partly because they may have persistent effects. In development discourse, this latter concern has spurred interest in the concept of resilience and how public interventions can enhance resilience. Within this context, we assess the impact of a social protection program, Ethiopia's Productive Safety Net Program, on the longer term impacts of drought on household food security. We find that drought shocks reduce the number of months a household considers itself food secure and that these impacts persist for up to four years after the drought has ended. Using a Hausman instrumental variable estimator, we find that receipt of PSNP payments reduced the initial impact of drought shocks by 57 percent and eliminates their adverse impact on food security within two years. In this way, the PSNP strengthens the resilience of its beneficiaries against adverse shocks. This impact is largest for PSNP beneficiaries with little or no land. Results are robust to using an objective measure of drought derived from satellite data, the Standard Evapotranspiration Index. They are also robust to changes in sample composition, the presence of other interventions, and the estimator used.

1. INTRODUCTION

The malign effect of shocks has long been a concern within economics. One long running strand of work, the consumption smoothing literature, has focused on whether these events result in transitory welfare losses (Carter et al. 2007; Dercon, Hoddinott and Woldehanna 2005; Zimmerman and Carter 2003). A second such strand, the "vulnerability" literature, examines what type of households are unable to smooth consumption (Dercon 2006). The third and more recent strand of work examines whether these shocks have long term adverse consequences (Alderman, Hoddinott, and Kinsey 2006; Barrett and Santos 2014; Hoddinott and Kinsey 2001; Mancini and Yang 2009). Increasingly, this third strand centers around the concept of resilience. While resilience as a concept has its earliest roots in engineering, it used most extensively in ecology and psychology. In ecology, Holling (1973) introduced the term, describing it as the amount of disturbance a system can absorb before shifting into an alternative state (Walker et al. 2006). Other writers focused on the speed of return to a pre-existing equilibrium following a perturbation or shock (Perrings 2006). Around the same time, psychologists also began exploring the notion of resilience (Garmezy 1974). In development, interest in resilience has arisen out of concern over the cumulative effect of humanitarian crises caused by climatic events and political instability. Viewed as a strategic approach to deal with the range of unpredictable risks that undermine efforts to reduce poverty and improve food security, resilience has emerged as a key concept for policy and program development (Bene et al. 2014; Constas, Frankenberger, and Hoddinott 2014; Walsh-Dilley, Woolford, and McCarthy 2016). Hoddinott (2014) writes, "resilience focuses attention on the idea that short-term shocks are malign not just because of their immediate effects but also because of their adverse long-term consequences".

Academic work on resilience has focused heavily on definition and measurement. There are a plethora of definitions (Barrett and Constas 2014; Bene et al. 2014; Constas, Frankenberger, and Hoddinott 2014), the most straightforward being that resilience is the "capacity that ensures adverse stressors and shocks do not have long-lasting adverse development consequences" (Constas, Frankenberger, and Hoddinott 2014). As Barrett and Constas (2014) note, this notion of capacity implies that resilience encapsulates attributes and supports that shift the likelihood function describing the relationship between shocks and outcomes such as consumption and food security. Efforts to measure resilience include constructing a multi-dimensional index (Alinovi, Mane, and Romano 2009) based on ex ante assessment of characteristics associated with resilience. Using a moments-based approach, Cisse and Barrett (2016) measure resilience ex-ante as the distribution of expected welfare over time. While this approach has desirable properties, it does not map recovery trajectories in response to specific shocks, which we perceive to be an important aspect of resilience. A third measurement approach uses cross-sectional household data to estimate vulnerability and resilience separately (Vollenweider 2015). Specifically, it uses a distributed lag non-linear model to estimate the lagged impact of past shocks on present consumption, and assuming the past is a good predictor of the future, uses these to project consumption trajectories into the future.

Building on the insight of Barrett and Constas (2014) that resilience is a capacity, the contribution of our paper is an assessment of how a social protection intervention shifts the relationship between shocks and outcomes. The setting is Ethiopia, the intervention is the Productive Safety Net Program (PSNP), one of the largest social protection programs in sub-Saharan Africa. Using longitudinal household data, we find that it takes households four years to recover from a drought shock. However, PSNP payments reduce vulnerability and increase resilience. At average payment levels, the PSNP reduces the post-drought drop in food security by 57 percent and eliminates the adverse impact of drought on food security within two years.

We begin with a brief description of the PSNP. Section 3 then outlines the model we estimate. Section 4 describes the data we use. Section 5 outlines our main results. Section 6 includes a set of robustness checks and Section 7 concludes.

2. ETHIOPIA'S PRODUCTIVE SAFETY NET PROGRAM

The genesis of Ethiopia's Productive Safety Net Program was a major drought in 2002-03 that resulted in more than 13 million people being left reliant on emergency food aid. While this assistance was successful in preventing outright starvation, it left untouched the underlying vulnerability of many Ethiopians to rainfall shocks. In response, the Government of Ethiopia, in consulation with major international donors, including the UK's Department for International Development, USAID, and the World Bank, developed a new intervention, the Productive Safety Net Program. Implementation of the PSNP began in January 2005. Operating in eight regions, the program provides benefits to approximately eight million people with a budget of approximately 500 million dollars per year. During preparatory work associated with the inception phase of the PSNP, discussions were held about the desirability of randomizing access to the program in order to evaluate the impact of the program. The Government of Ethiopia rejected this idea.

The goals of the PSNP are twofold: eliminate the food gap, the number of months the household cannot satisfy its food needs; and prevent distress sales, that is to stabilize household asset holdings (GFDRE 2009a). The PSNP is a targeted intervention. It does not operate everywhere in Ethiopia; rather, it is focused on *woredas* which historically have been drought-prone recipients of food aid.[1] Within *woredas*, households are selected using a process that combines both administrative and community mechanisms. Administrative mechanisms include the provision of a specified number of clients that can be included within a specific administrative area (*woreda*, *kebele*); guidance found in the PSNP's Program Implementation Manual (PIM) on targeting criteria to be used at the community level; and oversight to ensure transparency and accuracy. Household selection is carried out via community (*kebele*) targeting, particularly the identification of clients by community Food Security Task Forces (FSTF). The PIM specifies that households who are targeted should fall into the following categories: be community members; have faced continuous food shortages in the last three years; be acutely food-insecure due to a shock resulting in the severe loss of assets; lack adequate family support and other means of social protection and support;

[1] A *woreda* is equivalent to a county or district. A *kebele* is equivalent to a sub-district.

have a low level of household assets (land, livestock, land quality) relative to their neighbors; below average income from agricultural and nonagricultural activities; and households perceived to be vulnerable, such as female-headed households, elderly households, or households with chronically-ill members (GFDRE 2010, 24).

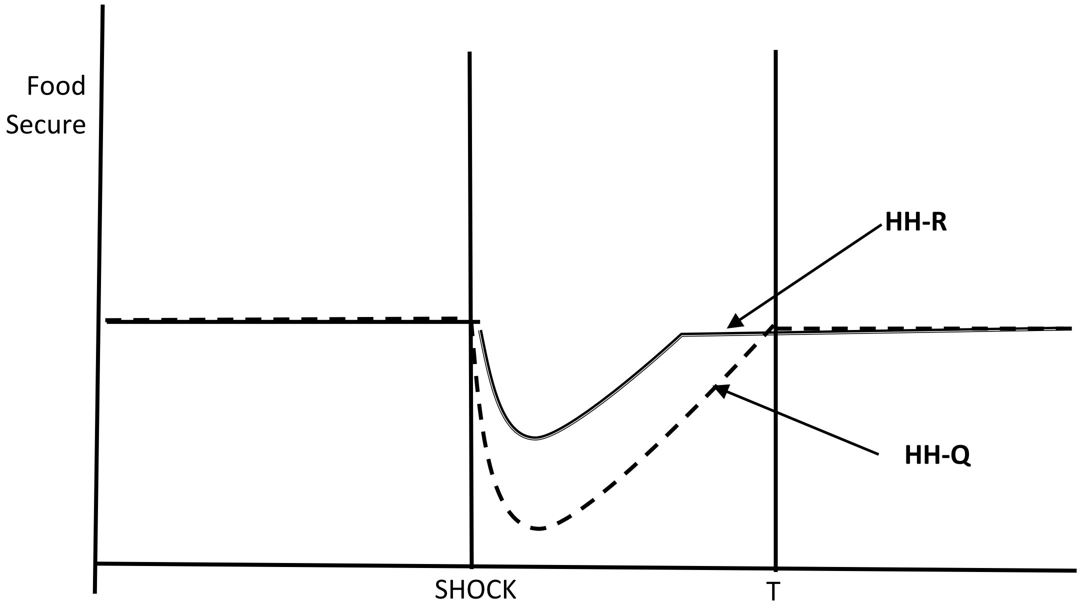
Payments are provided in the form of food and cash. Particularly in the early years of PSNP implementation, there were difficulties in ensuring these payments were regular and complete, and this was a particular problem for food payments (see Berhane et al. 2011, 2013, 2015; Gilligan et al. 2007, 2009). Most beneficiaries receive these payments for undertaking labor intensive public works. These works, which are intended to improve economic productivity, include road construction and maintenance; land rehabilitation; and small-scale water harvesting and irrigation works and well construction. This work is undertaken between January and June each year, the dry season in much of Ethiopia. There are variations in the amount of work done across woredas, reflecting woreda and regional decisions made about the type of public works to be undertaken, the labor intensity of that work, and random factors, such as delays in obtaining materials and obtaining access to complementary capital equipment (see Berhane et al. 2011, 2013; Gilligan et al. 2007, 2009). A smaller number, approximately 15 percent of the caseload, receive payments without having to work. This component, called Direct Support, is targeted largely to households unable to supply labor, such as those consisting of elderly persons or those with disabilities (Coll-Black et al. 2012).

3. CONCEPTUALIZING RESILIENCE AND ITS EMPIRICAL SPECIFICATION

Figure 3.1 provides a visual means of conceptualizing resilience. The horizontal axis is time. The vertical axis is a welfare outcome of interest to a policymaker. Given the objectives of the PSNP, we put household food security on the vertical axis. We represent the pre-shock path of food security for household Q by the chord HH-Q. A shock occurs which causes food security to fall. The magnitude of this initial drop can be thought of as capturing the household's vulnerability to shocks. Gradually, food security recovers, reaching pre-shock levels at time period T. The length of time it takes to recover from the shock can be thought of as a measure of resilience. Now consider a second household, R. It shares a similar pre-shock food security trajectory with household Q. However, when the shock occurs, household R is a beneficiary of a social protection intervention. This both reduces the magnitude of the initial shock and shortens the recovery period. The goal of our empirical work is to estimate these trajectories.

In this figure we focus on a consumption measure rather than assets. One reason for doing so is that consumption is a welfare measure; assets matter to the extent that they affect consumption, but they do not intrinsically contribute to welfare. Second, as Zimmerman and Carter (2003) and Hoddinott (2006) note, selling assets in response to shocks today risks permanently lowering future consumption and, in fact, a much older literature that focused on household behavior under famine conditions made this point explicitly – to sell off the meagre assets a household possessed under dire circumstances is to invite future destitution (Corbett 1988; Devereux 1993). Consequently, a focus on assets might obscure the true impact of the shock on household welfare. A third reason is more practical. Some PSNP beneficiaries are destitute. If these households are unable to borrow, a reasonable assumption in rural Ethiopia (Bernard & Spielman 2009), a shock has no effect on asset holdings because these holdings are already at zero. An asset based outcome would require us to either drop such households or assume that they were unaffected by a shock because we observed no change in their outcome metric.

Figure 3.1. Food security and resilience over time



Source: Hoddinott (2014a)
Notes: HH-R = beneficiary household; HH-Q = Non-beneficiary household

An empirical representation of Figure 3.1 for household Q is given by equation (1):

$$Y_{it} = \alpha + \sum_{l=t}^{t-L} \beta_l Shock_{il} + \gamma X_{it} + \epsilon_{it} \qquad (1)$$

Y_{it} is the outcome of interest, here a measure of household food security. The shock experienced by the household is denoted as $Shock_{il}$. Representing shocks in this way allows us to map the recovery trajectories within a household L periods after they experience a given shock, controlling for subsequent shocks. Absent a shock, food security is a function of X_{it}, a set of household level controls. In Figure 3.1, the pre-shock measure of food security reflects X_{it} and γ. The β s capture the impact of the shock. The coefficient on β_l when l = t captures the immediate effect of the shock. The coefficient on β_l when $l = t - L$ indicates whether a household is still experiencing adverse consequences to its welfare from a shock experienced in period t-L. So for example, β_{t-2} is the lagged impact on current welfare of a shock experienced two years previously. Rejecting the null of $\widehat{\beta_l} = 0$ or $l \in$ [t = 1; t =L] is strong evidence of the persistence of a shock's impacts. Estimating (1) allows us to plot that household's recovery trajectory, and therefore its resilience.

Now consider household R, the beneficiary of the social protection intervention. This household is a participant in the PSNP; further, we assume that the benefits of participation rise monotonically with the amount of payments it receives from the program. With this in mind, we introduce two new terms into equation (1): *Treat;* and *Treat x Shocks*. We write this as:

$$Y_{it} = \alpha + \sum_{l=t}^{t-L} [\beta_{1l} Shock_{il} + \beta_{2l} Treat_{il} + \beta_{3l} Treat_{il} * Shock_{il}] + \epsilon_{it} \quad (2)$$

We can infer the effect of payments as follows: β_{2l} is the effect of the treatment on the household food security absent any shock. We expect β_{2l} to be positive. β_{3l} is the main coefficient of interest, as it allows us to evaluate the program's effect on household vulnerability and resilience. In the short term, when l = t, it measures whether payments mitigate household vulnerability. A positive and significant coefficient would suggest that treatment decreased vulnerability. In the long term, when *l = t - L* we can plot the recovery trajectory of treated beneficiaries. A positive coefficient here reflect a more rapid recovery trajectory, indicating increased household resilience.

However, we face an endogeneity problem. In section 2, we explained that the PSNP is a targeted intervention. This targeting, on both food security outcomes as well as characteristics correlated with food security, implies that the payment levels received by beneficiary households might well be correlated with the disturbance term in (2), yielding biased parameter estimates. Some of this correlation can be accounted for by estimating a household fixed effects model that also includes time-varying household characteristics.

$$Y_{it} = \sum_{l=t}^{t-L} [\beta_{1l} S_{il} + \beta_{2l} T_{il} + \beta_{3l} T_{il} * S_{il}] + \gamma X_{it} + \mu_i + \epsilon_{it} \qquad (3)$$

Where for brevity we have substituted S for Shocks and T for Treatment. Under the assumption that after controlling for μ_i and X_{it} , E($T\ \varepsilon_{it}$) =0 and E(T x $Shocks\ \varepsilon_{it}$) =0, equation (3) yields unbiased estimates of $\beta_{1\ell}$, $\beta_{2\ell}$, and $\beta_{3\ell}$. Our initial estimates are based on this specification; in section 5.3, we report instrumental variable estimates of equation (3).

4. DATA

The data requirements for equation (3) are significant. We need a dataset with the following characteristics:

1. Longitudinal household data to allow for household fixed effects estimation.
2. A consistently measured outcome variable.
3. Shocks occurring within the data collection time-frame with both cross-sectional and temporal variation.
4. Data on payment levels with sufficient exogenous variation to identify program impacts.

4.1. Data collection

A feature of the PSNP is the bi-annual collection of longitudinal data on beneficiaries and non-beneficiaries, with five survey rounds having been conducted over a nine year period. The first survey in 2006 used a two stage clustered sampling approach. Across the four regions where the PSNP operated (Amhara; Oromiya; Southern Nations, Nationalities, and Peoples' (SNNP); and Tigray), 68 *woredas* were randomly selected using probability proportional to size (PPS) sampling based on estimated numbers of beneficiaries. Within each selected *woreda*, a random sample of two or three *kebeles* (depending on the region) was selected. Beneficiary lists were used to select randomly 17 PSNP households. Lists of non-beneficiaries were used to select an additional eight households, yielding a sample of 25 households per *kebele*. Additional survey rounds were implemented in 2008, 2010, 2012, and 2014.

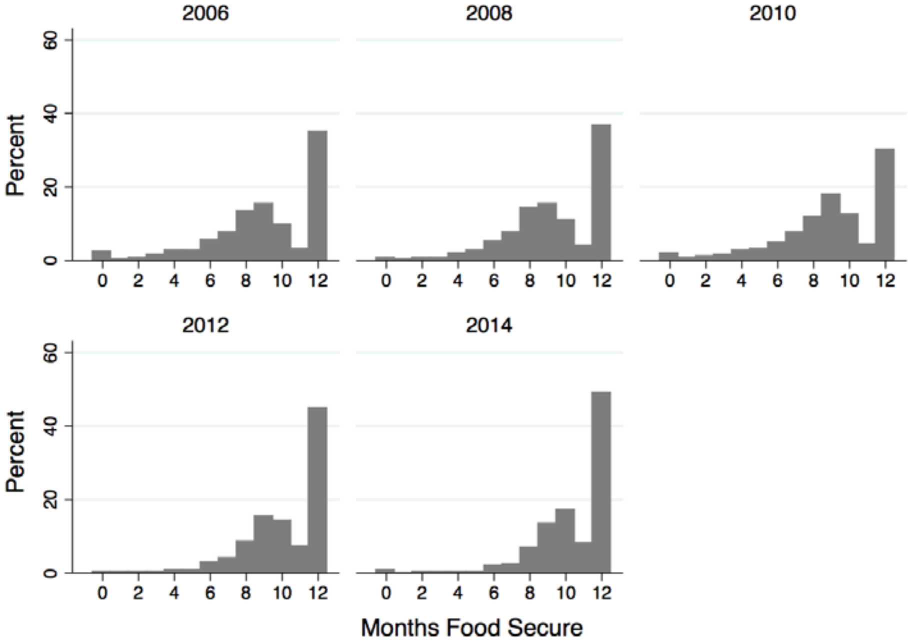
These surveys have a number of strengths. Data are collected at approximately the same time (June and July) in each round and so our results are not confounded by differences in survey timing across years. Questions pertaining to household food security, program participation, and shocks are identical across all rounds, as are a rich set of control variables. Both PSNP participants and non-participants are selected within the same geographic localities, meaning, inter alia, they are exposed to the same shocks and share the same time invariant and time varying locality characteristics. Attrition is low, approximately two percent per year. Much of this attrition is due to *kebeles* being dropped where the PSNP ceased operating.

Work investigating whether potential differences in attrition rates can be attributed to differences in baseline characteristics shows that being a program beneficiary was not correlated with the probability of attrition. Older and smaller households were slightly more likely to attrite than other household types, but the impact of these characteristics on attrition was small (Berhane et al. 2011, 2013).

4.2. Welfare variable: Months food secure

The primary goal of the PSNP was to reduce the food gap. This was measured by asking survey participants to report the number of months, out of the preceding 12 months, that they had "problems satisfying the food needs of the household" with a month where the household had "problems satisfying food needs" being defined as one where the household experienced hunger for five or more days. We convert this to "Months food secure" by starting with 12 months and subtracting the number of months when households reported having problems satisfying their food needs. This somewhat non-standard measure has two advantages. First, the Government of Ethiopia uses this to assess the impact of the PSNP.[2] Second, it allows us to measure food-security over a 12-month period. This contrasts with measures, such as caloric acquisition or food expenditures, that are typically reported over a shorter period, such as seven or 14 days. Such measures are more sensitive to seasonality and other factors that lead to short term fluctuations, which might mask our attempts to measure long run impacts.

Figure 4.1. Distribution of months food secure, proportion of respondent households by round



Source: Analysis by authors of PSNP survey rounds.

Figure 4.1 shows how months food secure has evolved over the nine years covered by the PSNP surveys. In general, food security improves with the distribution shifting rightwards over time. The proportion of household experiencing no reported hunger (12 months food secure) increases from 34.9 to 49.05 percent.

However, notice that this trend is not linear; reported food security deteriorates in the 2010 round, when the proportion of fully food secure household dropped to 29.98 percent. We know from rainfall data that Ethiopia experienced a severe drought in 2009. This deterioration is an example of drop in food security

[2] The "super goal" of the PSNP is the elimination of the food gap where the food gap is defined as 12-months food secure (Gilligan, Hoddinott, & Taffesse 2009)

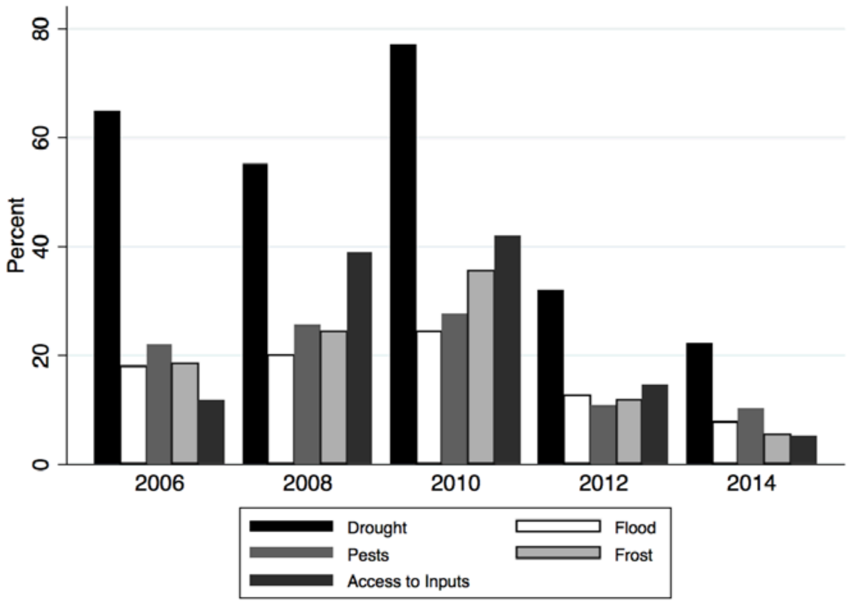
shown in Figure 3.1. The question which arises is whether access to the PSNP mitigated the effect of such a shock and whether it sped recovery from it.

4.3. Shock data

The survey instrument collects information on self-reported shocks. Specifically, households were asked: "We would like to learn about shocks in the last two years. Has this household been affected by a serious shock—an event that led to a serious reduction in your asset holdings, caused your household income to fall substantially, or resulted in a significant reduction in consumption? We would like to learn more about the worst shocks in the last 2 years." This was followed by 17 questions on different types of shocks that households might have experienced divided into three broad categories: Covariate climatic shocks, including drought, floods, frost and pest incidence; covariate economic shocks, including lack of access to inputs and price shocks affecting either inputs or outputs; and idiosyncratic shocks, such as death, disease, or divorce affecting a family member.

Figure 4.2 shows the five most frequently reported shocks by survey round. Drought is by far the most frequently reported shock. In every survey round, at least 20 percent of respondents reported being affected by drought in the two years preceding the survey, with this figure rising to nearly 80 percent in the 2010 round. Given their frequency, in our estimates below, "Shocks" are defined as equaling one if a household reports experiencing a drought shock in the two years prior to the survey.

Figure 4.2. Percent households reporting selected shocks in two years prior to survey round, by round



Source: Analysis by authors of PSNP survey rounds.

4.4. Treatment: PSNP Payments

All survey rounds collected self-reported information on payments received by PSNP beneficiaries from participation in the Public Works or from the Direct Support programs of PSNP. Specifically, for each survey round we know the total amount of payments that the household received in the nine months preceding the survey. These nine months overlap with the 12-month recall period for the food gap. We use these data to construct our measure of treatment, the value of PSNP payments.

Payments are received either as cash or in-kind (usually wheat or maize). In-kind payments are valued using data on local market prices. To account for inflation, which at times was substantial over the period covered by these surveys, we follow the methods outlined in Berhane, Hirvonen, and Hoddinott (2015). We construct a cereal price index, a weighted average of prices of the six main cereals (maize, teff, barley, wheat, sorghum, and millet) in a given community in a given year. We weight them by the consumption shares of each cereal type, collected at the household level and aggregated up to the community. Our price index thus captures both temporal and cross-sectional differences in price levels. We then deflate nominal payments using 2014 as a benchmark. Payments are expressed in 100 birr increments with each increment equivalent to about 5 USD in 2014.[3] Table 4.1 reports these payments by region and year.

Table 4.1. Mean PSNP payment received, by year and region, real 100 birr units

	PSNP survey round					
Region	**2006**	**2008**	**2010**	**2012**	**2014**	**Total**
Tigray	6.16	3.84	4.66	8.06	5.70	5.63
	(10.30)	(7.42)	(8.63)	(12.69)	(11.44)	(10.30)
Amhara	2.34	0.79	1.36	5.06	3.36	2.62
	(4.65)	(2.33)	(6.04)	(10.06)	(8.15)	(7.20)
Oromiya	5.84	2.88	2.06	10.59	7.29	5.61
	(9.89)	(5.41)	(5.26)	(19.93)	(16.48)	(12.87)
SNNP	4.72	3.78	6.18	7.47	5.24	5.44
	(7.55)	(6.35)	(11.21)	(12.23)	(11.20)	(9.97)
Total	4.81	2.33	3.04	7.03	4.88	4.38
	(8.56)	(5.27)	(7.94)	(13.34)	(11.37)	(9.83)

Source: Analysis by authors of PSNP survey rounds.
Real price (2014) index adjusted values, reported in 100 birr increments. 100 birr ≈ 5 USD in 2014.
Standard deviation in parentheses

4.5. Additional controls

In addition to household fixed effects, we control for household land ownership; education, as a proxy for human capital; and the age, size, and gender composition of the household. Some of these variables, such as household size, are correlated with household food security and so their inclusion improves the precision of our parameter estimates, while others, such as land ownership, are correlated with both household food security and the likelihood of receiving PSNP payments. Descriptive statistics for these control variables in two rounds, 2006 and 2014, are shown in Table 4.2.

[3] Because this is expressed in real terms, these figures may differ from previous papers such as Berhane et al. (2014).

Table 4.2. Selected household characteristics, mean values, by round and PSNP status

	PSNP Beneficiary	Non-PSNP Beneficiary	p-value
First round – 2006			
Landholding size (ha)	1.28	1.17	0.00
Age of household head (years)	44.39	45.98	0.00
Education of household head (years)	0.54	0.47	0.04
Household head is male	0.78	0.74	0.01
Number of males 0-6 years of age	0.59	0.61	0.42
Number of females 0-6	0.58	0.61	0.27
Number of males 7-15	0.67	0.70	0.37
Number of females 7-15	0.63	0.67	0.22
Number of males 16-60	1.08	1.02	0.02
Number of females 16-60	1.14	1.15	0.73
Number of males >60	0.12	0.13	0.40
Number of females >60	0.09	0.12	0.02
Last round – 2014			
Landholding size (ha)	1.18	0.96	0.00
Age of household head (years)	49.70	51.82	0.00
Education of household head (years)	0.57	0.41	0.00
Household head is male	0.79	0.61	0.00
Number of males 0-6 years of age	0.51	0.42	0.00
Number of females 0-6	0.50	0.42	0.00
Number of males 7-15	0.92	0.76	0.00
Number of females 7-15	0.83	0.77	0.09
Number of males 16-60	1.23	1.05	0.00
Number of females 16-60	1.27	1.22	0.07
Number of males >60	0.17	0.16	0.29
Number of females >60	0.11	0.19	0.00

Source: Analysis by authors of PSNP survey rounds.

5. RESULTS

5.1. Ordinary least squares estimates

We begin by estimating equation (1). While this does not include the impact of the PSNP, it provides a first look at how reported drought shocks affects household food security. Results are shown in Table 5.1. Column (1) reports the contemporaneous effect of drought with columns (2) and (3) incorporating additional lags in the drought variable to reflect long term effects.[4] Table 5.1 shows that drought reduces food security and that it has persistent effects. Given our definition of shocks, each lag is equivalent to two years. Column (3), for example, indicates that a drought shock reduces initial food security by 1.56 months. Two years after the drought occurs, food security is still reduced by 0.55 months and four years after the drought, food security is reduced by 0.35 months.

[4] We test and reject unit roots for our lagged variables. For robustness, we ran the above specification with a Prais-Winsten feasible generalized least squares estimator and got qualitatively equivalent coefficients of the same sign and significance. Results are available on request.

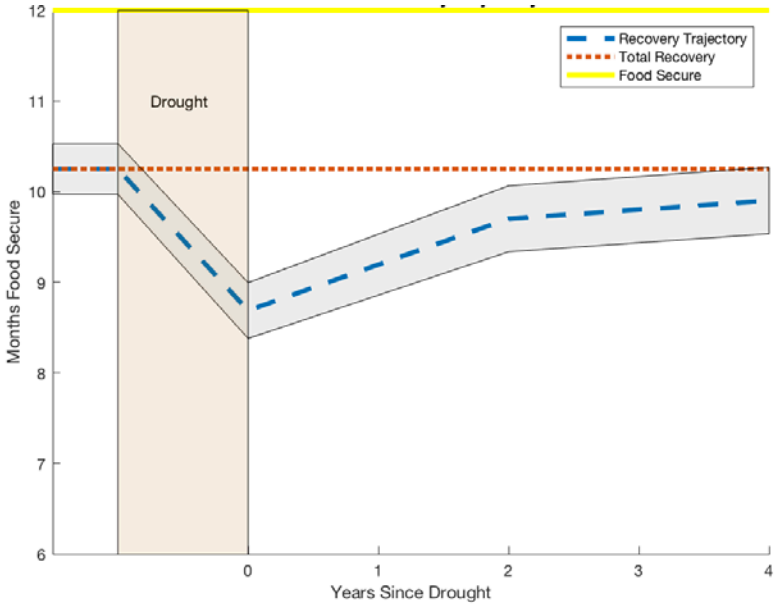
Table 5.1 Impact of drought on months food secure, by lagged drought

	(1) Months Food Secure	(2) Months Food Secure	(3) Months Food Secure
drought	-1.314***	-1.411***	-1.564***
	(0.0908)	(0.0929)	(0.101)
L2.drought		-0.363***	-0.546***
		(0.0778)	(0.0918)
L4.drought			-0.349***
			(0.0934)
_cons	9.981***	10.090***	10.250***
	(0.0291)	(0.0376)	(0.0563)

Source: Analysis by authors of PSNP survey rounds.
Observations: 8,005. Standard errors in parentheses; * p<0.10, ** p<0.05, *** p<0.01

In Figure 5.1, we construct a version of Figure 3.1 by taking the results from column (3) in Table 5.1 and plotting them along with their 95% confidence intervals. We take the constant as representing a baseline level of 10.25 months food secure for a representative household. Assuming the household suffers from drought, its level of food security can be computed as $\widehat{\beta}_0 + \widehat{\beta}_{drought} \approx 10.25-1.56 = 8.69$ months food secure. To infer the effects of the drought two year after it ends we compute $\widehat{\beta}_0 + \widehat{\beta}_{L.drought} \approx 10.25 - 0.55 = 9.7$ months food secure. Up to four years after the drought ends the household is still less food secure than it would have been otherwise.

Figure 5.1. Recovery trajectory from drought



Source: Based on analysis by authors of PSNP survey rounds presented in Table 5.1, column (3).
Representative household at mean level of food security. Grey band represents 95% confidence intervals.

Next, we estimate equation (3). The results are reported in Table 5.2. Looking at the coefficients on the interaction terms in column (3), we again see that drought shocks reduce food security. The interaction terms between drought shocks and PSNP payments is positive, indicating that the PSNP offsets some of the impact of drought. However, the magnitude of this effect is small; at mean payment levels, PSNP payments reduce the effect of the drought by roughly 0.1 months.

Table 5.2. Impact of drought and payments on months food secure, household fixed effects

	(1)	(2)	(3)
PSNP Payment	0.002	0.002	0.004
	(0.004)	(0.005)	(0.005)
Drought in past year	-0.897***	-0.811***	-1.020***
	(0.220)	(0.243)	(0.227)
PSNP Payment * Drought in past year	0.014**	0.018**	0.015*
	(0.006)	(0.007)	(0.008)
PSNP Payment 2 years ago		0.005	0.007
		(0.005)	(0.005)
Drought 2 years ago		0.205	-0.038
		(0.234)	(0.252)
PSNP Payment * Drought 2 years ago		0.009	0.003
		(0.008)	(0.011)
PSNP Payment 4 years ago			0.008
			(0.008)
Drought 4 years ago			-0.416*
			(0.222)
PSNP Payment * Drought 4 years ago			-0.023
			(0.014)

Source: Analysis by authors of PSNP survey rounds.
Observations: 8,005. Coefficients correspond to equation (3), where S_{it} is the incidence of drought and T_{it} is the PSNP payment.
* p<0.10, ** p<0.05, *** p<0.01. Standard errors in parentheses

5.2. Instrumental variables estimates

Results in Table 5.2 control for household fixed effects and the time varying household characteristics. This removes much of the potential correlation between the disturbance term and PSNP treatment, but possibly not all. To address this, we need instrumental variables that are correlated with payments but not correlated with household food security.

Furthermore, to address concerns that *kebele* (sub-district) level program implementation is correlated with beneficiary household unobservables, we use these exogenous variables to construct a Hausman instrument (Hausman 1994). We aggregate the characteristics at the *woreda* (district) level and take the average, excluding own-*kebele* characteristics.

$$OtherZ_{jt} = \frac{\sum_{i=1}^{|K|} Z_{ijk} - \sum_{i=1}^{|J|} Z_{ijk}}{|K| - |J|} \quad (4)$$

Where K is the set of observations in a given *woreda*, and J the set of observations in a *kebele*. This reflects underlying trends in program implementation at the *woreda* level that would affect the *kebele*, but excludes potential correlation with *kebele* level un-observables, which may be correlated with individual outcomes.

Our description of the PSNP in section 2 suggests the following candidates for exogenous instrumental variables:

- Total number of months in which public works were undertaken. An increase in the number of months when the PSNP employed beneficiaries in the *woreda* as a whole could be positively correlated with payments at the household level if it reflects greater resource availability overall. However, because our Hausman instrument explicitly excludes own *kebele*s, it is possible that an increased allocation elsewhere in the *woreda* would imply decreased resource availability in the household's *kebele*, leading to a negative correlation. The mean number of months of public works is 5.4.

- An indicator variable equaling one if any payments were made in cash. Analysis of PSNP payment processes showed that cash payments were made in a more complete and timely fashion than payments made in-kind (see Berhane et al. 2011, 2013). However, in years of high inflation, food payments were more likely to retain their purchasing power (Berhane et al. 2011) suggesting that the cash payment reduces the real value of payments. This indicator has a mean of 0.84.
- An indicator variable constructed as the interaction between the cash payment dummy described above and distance to the nearest town in km. As Berhane et al. (2011, 2013, 2015) show, distances beneficiaries must travel to payment sites can be large, particularly for food payments. Cash payments may overcome, to some extent, the difficulties that more remotely located households might have in receiving the payments. In other words, we expect that cash payments increase the likelihood of household receiving payments and that this correlation gets stronger the more remotely located is the household. We proxy remoteness with distance from the center of the *kebele* to the nearest town. The mean of this interaction term is 12.9.

Table 5.3 shows the correlations between these instruments and payments received by PSNP households. (Note that the sample size is larger than that reported in other tables because we include lagged treatment variables.) Note that we create instruments for our endogenous interaction term by interacting the instrument with the exogenous variable, drought.

Table 5.3. Instrument relevance: first stage regressions for endogenous variables

	PSNP Payments	PSNP Payments * Drought
Public Works Months	-0.013***	
	(0.004)	
Cash Payments	0.210***	
	(0.066)	
Cash Payments * Distance to Town	0.002***	
	(0.000)	
Public Works Months * Drought		0.507***
		(0.160)
Cash Payments * Drought		2.259**
		(1.116)
Cash Payments * Distance to Town * Drought		-0.040***
		(0.010)
F	35.982	6.834

Source: Analysis by authors of PSNP survey rounds.
Observations: 15,604. Used entire sample to instrument the set of endogenous variables. Standard errors in parentheses.
* p<0.10, ** p<0.05, *** p<0.01

Table 5.3 shows a negative correlation between village level payment and own payments. Though seemingly counter-intuitive, recall that this is a Hausman instrument at the *woreda* level, explicitly excluding payments from the household's own *kebele*. Hence the negative correlation suggests that, given a fixed budget, an increase in public works provided to other *kebele*s reduces the amount of work (and therefore payments) to the own *kebele*. Receiving payments in cash is positively correlated with level of payments, possibly due to the reasons described above. Our interaction between cash payment and distance is also positively correlated, suggesting that cash helps overcome remoteness to a certain extent.

Table 5.4. Impact of drought and payments on months food secure, instrumental variables and fixed effects model

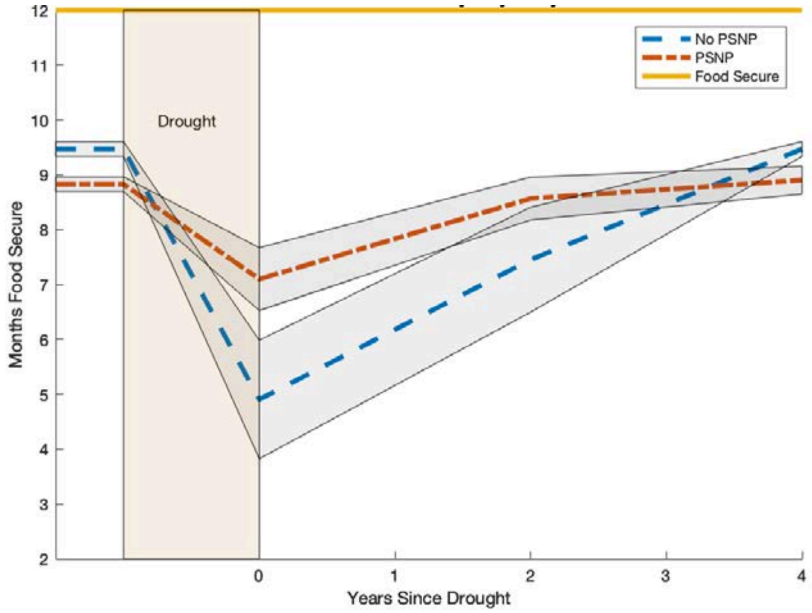
	(1)	(2)	(3)
PSNP Payment	0.019	0.049**	0.078***
	(0.034)	(0.024)	(0.022)
Drought in past year	-4.089***	-3.678***	-4.530***
	(1.351)	(0.376)	(0.606)
PSNP Payment * Drought in past year	0.488**	0.539***	0.556***
	(0.220)	(0.112)	(0.135)
PSNP Payment 2 years ago		0.099	0.023
		(0.087)	(0.058)
Drought 2 years ago		-1.516*	-2.079***
		(0.798)	(0.498)
PSNP Payment * Drought 2 years ago		0.361*	0.360***
		(0.193)	(0.120)
PSNP Payment 4 years ago			0.110
			(0.075)
Drought 4 years ago			-0.742
			(0.629)
PSNP Payment * Drought 4 years ago			-0.059
			(0.158)
Hansen J-Test	0.906	0.529	0.500

Source: Analysis by authors of PSNP survey rounds.
Equation 3) instrumented. Observations: 8,005. Observations restricted to 2010, 2012, and 2014 due to double-lagged structure.
Standard errors in parentheses. * p<0.10, ** p<0.05, *** p<0.01

Table 5.4 reports the results of estimating equation (3) with a system generalized method of moments (GMM) estimator. Standard errors are clustered at the *kebele* level. We present three estimates: column (1) reports findings with no lags; column (2) reports a two-year lag structure, while column (3) gives the results with a four-year lag structure. Noting that the coefficients on the initial drought shocks and the interaction term between the initial drought shock and PSNP payments are similar across all three columns, we focus on column (3).

As we saw earlier, drought shocks reduce food security, and the magnitude of their effect is large. Using column (3), a household reporting a drought shock in the previous 12 months saw its months food secure fall by 4.5 months. PSNP payments offset much but not all of this initial shock. Recall that mean payments are approximately 500 birr per year and that in Table 5.4, payments are reported in 100 birr increments. This means that for the average beneficiary, PSNP payments offset 2.8 months of the drought shock ((500 birr/100) =5 multiplied by the coefficient 0.56), a 57 percent reduction in vulnerability. There is a lagged effect of drought; in column (3), this is a reduction of 2.1 months in food security two years after the drought ended. However, at the mean level of payments, this is nearly completely offset by PSNP payments (5 multiplied by 0.36 = 1.8). By contrast, households not receiving any PSNP payments do not benefit from this mitigation and suffer the full effect of the drought. They do not return to their pre-drought level of food security until four years after the drought ended (column (3)). Figure 5.2 graphs these trajectories for PNSP households receiving mean levels of payments and non-PSNP households. Table 5.4 and Figure 5.2 convey the core findings of this paper.

Figure 5.2. PSNP and non-PSNP recovery trajectories



Source: Based on analysis by authors of PSNP survey rounds presented in Table 5.4, column (3). Representative household at mean level of food security. Grey band represents 95% confidence intervals.

The magnitude of the coefficients on payments and the interaction term using the instrumental variable specification (Table 5.4) increases substantially relative to our OLS fixed effects specification (Table 5.2). This suggests that, while our OLS specification controlled for both household fixed effects and some time varying household characteristics that were correlated with program targeting criteria, they did not control for other unobservable factors that were correlated with both payments and the extent of food insecurity. Using both the OLS and IV estimates, we constructed a Hausman test. This rejected the null hypothesis that the OLS estimates were unbiased. We constructed a Hansen J-test. P-values are reported at the bottom of Table 5.4; these show that we do not reject the null hypothesis of the validity of our instruments.

Results in Table 5.4 assume that the impact of shocks and of the PSNP is the same across all households. This may not be true. For example, relatively wealthier PSNP households may be better able to consumption smooth in the face of shocks, something our estimates do not take into account. We consider heterogeneous effects across four household characteristics: landholdings; baseline (2006) food security; baseline (2006) livestock holdings; and household heads' educational attainment.[5]

We disaggregate our sample into two groups: households with landholdings less than or equal to one hectare; and households with more than one hectare of land.[6] Results are shown in Table 5.5. Column (1) is the aggregate result, column (2) shows results for household with 1 ha of land or less and column (3) show results for households with more than 1 ha of land. Drought shocks have a larger effect on households with smaller landholdings. However, for these poorer households, payments have a relatively larger offsetting effect, implying that PSNP payments have a particularly powerful effect on enhancing the resilience of poor households. This is seen clearly when we use the results from Table 5.5 to graph the food security trajectories of PSNP and non-PSNP households, disaggregating by landholding size. Households with more than one hectare of land suffer a smaller reduction in food security and recover more quickly compared to

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[5] We use baseline values for these because subsequent values may be affected by both drought and payments received from the PSNP.

[6] An alternative approach would be to split the sample into two groups of equal size. However, because a large fraction of the sample reported operating exactly one hectare of land, this was not feasible.

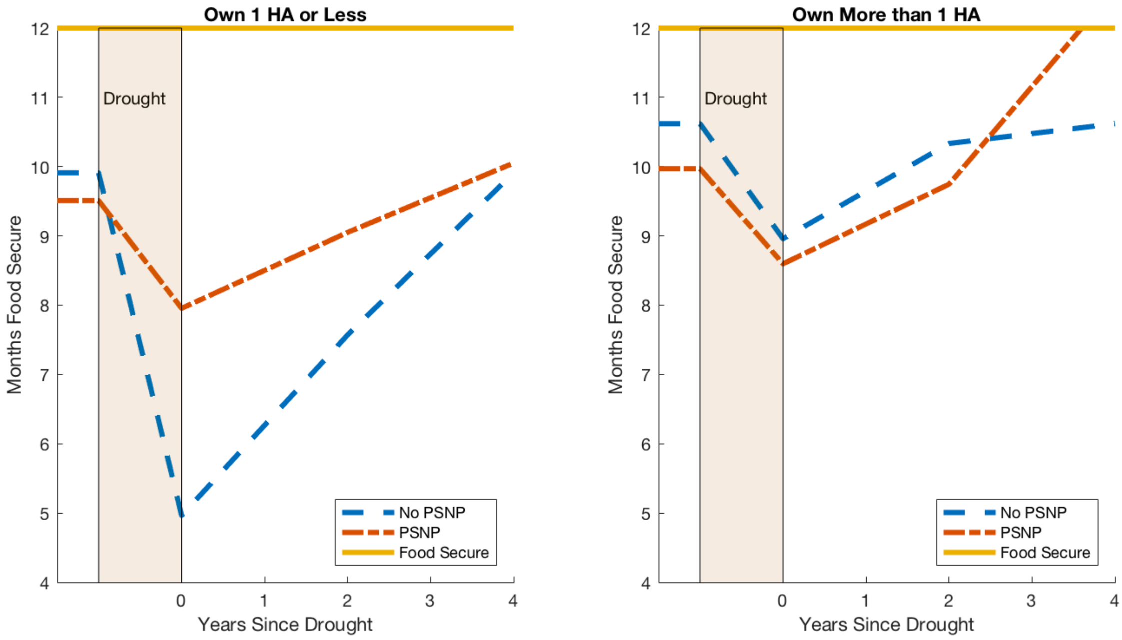
households with one hectare or less. Among households with less than one hectare of land, the PSNP cushions the initial effects of drought shocks and permits a faster recovery from them.

Table 5.5. Impact of drought and payments on months food secure, instrumental variables and fixed effects model, disaggregated by land area operated

	(1) All	(2) Households owning 1.0 ha or less of land	(3) Households owning more than 1.0 ha of land
PSNP Payment	0.078***	0.033	0.161***
	(0.022)	(0.027)	(0.038)
Drought in past year	-4.530***	-6.490***	-2.026***
	(0.606)	(1.146)	(0.549)
PSNP Payment * Drought in past year	0.556***	0.939***	0.207*
	(0.135)	(0.181)	(0.120)
PSNP Payment 2 years ago	0.023	-0.056	0.205**
	(0.058)	(0.065)	(0.083)
Drought 2 years ago	-2.079***	-2.807***	-0.174
	(0.498)	(0.680)	(0.704)
PSNP Payment * Drought 2 years ago	0.360***	0.512***	0.098
	(0.120)	(0.149)	(0.157)
PSNP Payment 4 years ago	0.110	0.028	0.112
	(0.075)	(0.058)	(0.070)
Drought 4 years ago	-0.742	-2.771**	-0.340
	(0.629)	(1.149)	(0.374)
PSNP Payment * Drought 4 years ago	-0.059	0.545*	-0.107
	(0.158)	(0.280)	(0.122)
Observations	8,005	5,928	2,077

Source: Analysis by authors of PSNP survey rounds.
Observations restricted to 2010, 2012, and 2014 due to double lagged structure. Standard errors in parentheses.
* p<0.10, ** p<0.05, *** p<0.01.

Figure 5.3. Recovery trajectories, disaggregated by landholding size



Source: Based on analysis by authors of PSNP survey rounds presented in Table 5.5. Representative household at mean level of food security.

Next, we disaggregate by initial (2006) household food security. Specifically, we disaggregate the sample based on whether the household had food security above or below the mean level for its region in 2006. Results are shown in Table 5.6. Column (1) is the aggregate result, column (2) results for household below the mean and column (3) for households above the mean. Results are similar to those found for the landholding size disaggregation. Households that initially are more food insecure experience a greater reduction in food security following a drought shock compared to more food secure households. However, among these initially food insecure households, recovery from drought is faster when they receive PSNP payments.

Table 5.6. Impact of drought and payments on months food secure, instrumental variables and fixed effects model, disaggregated by baseline food security

	(1) All	(2) Households less food secure than mean in 2006	(3) Households more food secure than mean in 2006
PSNP Payment	0.078***	-0.001	0.152***
	(0.022)	(0.026)	(0.045)
Drought in past year	-4.530***	-5.350***	-3.522***
	(0.606)	(0.647)	(1.131)
PSNP Payment * Drought in past year	0.556***	0.736***	0.368**
	(0.135)	(0.158)	(0.154)
PSNP Payment 2 years ago	0.023	-0.181***	0.126*
	(0.058)	(0.063)	(0.074)
Drought 2 years ago	-2.079***	-3.756***	-1.034*
	(0.498)	(0.674)	(0.573)
PSNP Payment * Drought 2 years ago	0.360***	0.743***	0.177*
	(0.120)	(0.150)	(0.104)
PSNP Payment 4 years ago	0.110	0.021	0.300**
	(0.075)	(0.072)	(0.142)
Drought 4 years ago	-0.742	-2.116***	1.522
	(0.629)	(0.672)	(1.036)
PSNP Payment * Drought 4 years ago	-0.059	0.248	-0.462**
	(0.158)	(0.179)	(0.203)
Observations	8,005	4,296	3,709

Source: Analysis by authors of PSNP survey rounds.
Observations restricted to 2010, 2012, and 2014 due to double lagged structure. Standard errors in parentheses.
* p<0.10, ** p<0.05, *** p<0.01.

We also disaggregated the survey sample by initial (2006) livestock holdings. Specifically, we disaggregated the sample based on whether the household had livestock holdings above or below the mean level for the region it resided in. We also disaggregated the survey sample by whether the household head had any formal schooling. In both instances, we find no differences in treatment effects across these disaggregations. Results are available on request.

6. ROBUSTNESS CHECKS

We consider five potential concerns regarding our results: measuring drought through the use of self-reported shocks; sample composition; the presence of other interventions; alternative estimators; and accounting for time effects.

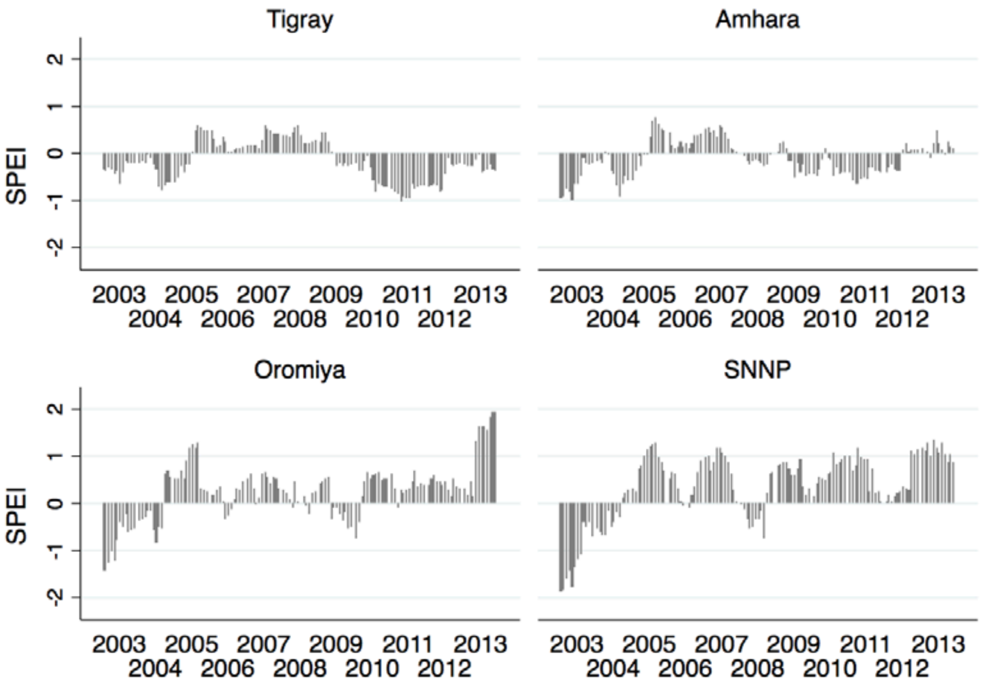
6.1. Self-reported versus measured shocks

Our results are based on household self-reports of drought shocks. To the extent that these capture a households' perception of what has occurred rather than what actually occurred, they may contain measurement error. Reverse causality is another possibility. Beneficiaries may mistakenly believe that receiving payments is conditional on experiencing a shock and so report that these have occurred even when they did not. All these possibilities will result in biased parameter estimates.

We can address these by replacing our self-reported shocks with measured shocks. To do so, we obtained geospatial climate data, specifically the Standardized Precipitation-Evapotranspiration Index (SPEI).[7] SPEI was developed as a multi-dimensional measure of drought incorporating the effects of variations in precipitation and temperature. It combines two widely accepted measures, the Palmer Drought Severity Index (PDSI) and the Standardized Precipitation Index (SPI). It is available from 1901 to 2013 with a 0.5 degrees spatial resolution and monthly frequency.

SPEI, based on the water balance equation, measures wetness as positive values and dryness as negative values, incorporating prior precipitation, moisture supply, runoff, and evapo-transpiration. It is a relative probability index sensitive to timescale. Intuitively, what constitutes an episode of drought or flooding depends on the pre-existing agro-ecological context. This determines what is 'enough' water, and the lag between the arrival of water inputs, as rain or runoff, to its availability for watering crops or livestock. This comparison between actual and historical can be made over different timescales allowing the user to distinguish between hydrological, environmental, and other droughts. We used a 12-month timescale, capturing variations in drought conditions over the year, reasoning that this was the scale that most affected households in our sample would have employed as well as being most comparable to our self-reported drought measure. Since the available SPEI datasets are at the global level, we extracted observations for Ethiopia. SPEI data were matched to individual *woreda*s' GIS coordinates using inverse distance weighting.

Figure 6.1. Standardized Precipitation Evapotranspiration Index (SPEI), by region and year



Source: Standardized Precipitation Evapotranspiration Index (SPEI) extracted by authors from global spatial dataset by region over a 12 month timescale.

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[7] Downloaded from: http://sac.csic.es/spei/database.html

Figure 6.1 illustrates SPEI in Ethiopia by region. Values less than zero indicate drought conditions; a cursory comparison with Figure 4.2 suggests that these measured drought shocks correspond with the frequency of self-reported shocks; most notably in 2009.

Using these SPEI data, we run the same IV specification as in Table 5.4, using the same set of lags for previous droughts, but replacing our binary variable for self-reported drought with a new binary variable that equals one if the average of 12 month's prior SPEI was less than zero. When we do so, we obtain similar results to those reported in Table 5.4 (see Supplementary Table 1).

6.2. Sample composition

Our sample includes households in the Amhara region of Ethiopia. Some of these households received PSNP payments through funding provided by the US government. These payments were all in the form of in-kind payments. Given our IV strategy, we wondered if their inclusion affected our results. As a robustness check, we excluded these households and re-ran the IV model used to estimate equation (3). Doing so gave similar results (see Supplementary Table 2).

As noted in section 2, some PSNP beneficiaries, those with no able bodied members, such as widows, orphans and disabled individuals unable to perform public works, received unconditional payments called Direct Support. Their payments might be unaffected by one of our instruments, the number of months when public works employment was provided. As a robustness check, we also excluded these households and re-ran the IV model used to estimate equation (3). Doing so gave similar results (see Supplementary Table 3).

6.3. Other interventions

Suppose that in addition to the PSNP, there was another intervention operating in the *woreda*s in our sample and that it had a similar beneficiary profile. If this were the case, we might incorrectly ascribe the impact of such a program to the PSNP.

There is only one such program that fits this description. Initially, the PSNP was complemented by a series of food security activities called the Other Food Security Program (OFSP) (Berhane et al. 2014). The OFSP aimed to increase incomes through the provision of credit for activities that would improve crop and livestock production. Problems with its implementation led to a re-design; the replacement program, the Household Asset Building Program (HABP) had a greater emphasis on technical assistance. Both the OFSP and HABP were intended to assist a subset of PSNP beneficiaries.

As a robustness check, we re-estimated equation (3) including as an additional control, participation in the OFSP/HABP. Doing so had no substantive effect on our estimates (Supplementary Table 4).

6.4. Alternative estimators

Our dependent variable is a discrete count variable, taking on integer values from 0 to 12. As a robustness check, we estimated equation (3) using a household fixed effects instrumental variable Poisson maximum likelihood estimator. Poisson household fixed effect results are presented in Supplementary Table 5, while instrumental variable Poisson household fixed effect results are presented in Supplementary Table 6. Because we use a non-linear estimator, in order to recover the average marginal effect, we must multiply the coefficients by the sample average of the outcome variable. The results are consistent with the results reported in Table 5.4 in sign, magnitude, and significance. For example, using the model specification with two lags, the marginal effect of the interaction term PSNP payment by drought in past year is 0.39 which is statistically indistinguishable from the equivalent coefficient reported in Table 5.4, column (3).

6.5. Accounting for time effects

Results such as those shown in Figure 4.1 suggest that we should be concerned about controlling for time (secular) trends. Doing so, however, is not without its own problems. In particular, there is a high correlation between reported drought shocks and some of our survey years – most notably 2010 – making it infeasible to include survey round dummies. We note that we control for some of the effects of secular change; for example our price deflator ensures that the effect of inflation on payments is taken into account. At the household level, our inclusion of the age of the household head will also capture some of these secular trends.

Yet, despite all this, one might be concerned about time trend effects. A further way of addressing this is to detrend our dependent variable. As a robustness check, we did so, subtracting the predicted outcome from the time trend alone.[8] The results are available in Supplementary Table 7 and are consistent with our principal results in sign, significance, and magnitude.

7. CONCLUSION

The malign effect of shocks has long been a concern within economics, partly because they result in transitory welfare losses and partly because they may have persistent effects. In development discourse, this latter concern has spurred interest in the concept of resilience and how public interventions such as social safety nets can enhance resilience. However, operationalizing these ideas has been constrained by their daunting data requirements which include: (1) longitudinal household data to allow for household fixed effects estimation; (2) a consistently measured outcome variable; (3) measured shocks that occur within the data collection time-frame with both cross-sectional and temporal variation; and (4) data on payment levels with sufficient exogenous variation to identify program impacts.

Within this context, we assess the impact of a social protection program, Ethiopia’s Productive Safety Net Program, on the longer term impacts of drought on household food security. Surveys conducted over multiple years satisfy these data requirements. We find that drought shocks reduce the number of months a household considers itself food secure and that these impacts persist for up to four years after the drought has ended. Using a Hausman instrumental variable estimator, we find that receipt of PSNP payments reduced the initial impact of drought shocks by 57 percent and eliminates their adverse impact on food security within two years. In this way, the PSNP strengthens the resilience of its beneficiaries against adverse shocks. This impact is largest for PSNP beneficiaries with little or no land. Our results are robust to how shocks are measured, changes in sample composition, the presence of other interventions, and the estimator used. If these findings can be replicated with other programs in other settings, they suggest that social protection interventions are a mechanism for mitigating the adverse effects of climatic shocks.

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[8] Specifically, we regressed $MonthsFoodSecure=\gamma_0 + \Sigma\gamma_t Round_t + \varepsilon_{it}$ and generated the predicted variable \hat{MonthsFoodSecure}$_{Trend}$. $MonthsFoodSecure_{detrend}=MonthsFoodSecure - MonthsFoodSecure_{Trend}$

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SUPPLEMENTARY TABLES

Supplementary Table 1. Instrumental Variable (IV) model, using objective SPEI measure of drought occurrence

	(1)	(2)	(3)
PSNP Payment	0.103	-0.109	0.030
	(0.093)	(0.090)	(0.056)
Negative SPEI in past year	0.855	-1.085	-1.966**
	(0.782)	(0.728)	(0.771)
PSNP Payment * Negative SPEI in past year	-0.134	0.328**	0.397***
	(0.141)	(0.156)	(0.114)
PSNP Payment 2 years ago		0.014	-0.028
		(0.076)	(0.091)
Negative SPEI 2 years ago		-2.342***	-3.132***
		(0.717)	(0.950)
PSNP Payment * Negative SPEI 2 years ago		0.311***	0.379***
		(0.100)	(0.129)
PSNP Payment 4 years ago			0.080
			(0.071)
Negative SPEI 4 years ago			-1.702***
			(0.562)
PSNP Payment * Negative SPEI 4 years ago			0.269**
			(0.122)
Observations	8,005	8,005	7,594
J-Test P-value	0.2857	0.3932	0.3861

Source: Analysis by authors of PSNP survey rounds.
SPEI: Standard Precipitation Evapotranspiration Index, negative values indicate drought conditions. Standard errors in parentheses.
* p<0.10, ** p<0.05, *** p<0.01.

Supplementary Table 2. Instrumental Variable (IV) model, excluding households in woredas that received PSNP payments through funding provided by US government

	(1)	(2)	(3)
PSNP Payment	0.056**	0.077***	0.194***
	(0.027)	(0.023)	(0.024)
Drought in past year	-3.718***	-3.458***	-3.837***
	(0.852)	(0.423)	(0.514)
PSNP Payment * Drought in past year	0.409***	0.509***	0.479***
	(0.140)	(0.114)	(0.109)
PSNP Payment 2 years ago		0.173**	0.084*
		(0.069)	(0.045)
Drought 2 years ago		-0.791	-0.966**
		(0.740)	(0.378)
PSNP Payment * Drought 2 years ago		0.281	0.180*
		(0.199)	(0.105)
PSNP Payment 4 years ago			0.097*
			(0.052)
Drought 4 years ago			-0.316
			(0.466)
PSNP Payment * Drought 4 years ago			-0.085
			(0.141)

Source: Analysis by authors of PSNP survey rounds.
Observations: 8,623. Standard errors in parentheses. * p<0.10, ** p<0.05, *** p<0.01.

Supplementary Table 3. Instrumental Variable (IV) model, excluding Direct Support beneficiary households

	(1)	(2)	(3)
PSNP Payment	0.015	0.046*	0.038***
	(0.040)	(0.023)	(0.013)
Drought in past year	-3.843***	-3.525***	-4.863***
	(1.259)	(0.351)	(0.513)
PSNP Payment * Drought in past year	0.414**	0.508***	0.581***
	(0.183)	(0.094)	(0.122)
PSNP Payment 2 years ago		0.136	0.050
		(0.090)	(0.051)
Drought 2 years ago		-1.384*	-2.106***
		(0.791)	(0.601)
PSNP Payment * Drought 2 years ago		0.332*	0.344***
		(0.170)	(0.123)
PSNP Payment 4 years ago			0.021
			(0.056)
Drought 4 years ago			-1.176**
			(0.478)
PSNP Payment * Drought 4 years ago			0.028
			(0.129)

Source: Analysis by authors of PSNP survey rounds.
Observations: 6,543. Standard errors in parentheses. * p<0.10, ** p<0.05, *** p<0.01.

Supplementary Table 4. Instrumental Variable (IV) model, with inclusion of an Other Food Security Program and Household Asset Building Program control

	(1)	(2)	(3)
PSNP Payment	0.013	0.055**	0.117***
	(0.027)	(0.023)	(0.021)
Drought in past year	-3.797***	-3.764***	-4.114***
	(1.136)	(0.324)	(0.529)
PSNP Payment * Drought in past year	0.414**	0.511***	0.465***
	(0.179)	(0.092)	(0.118)
Household Asset Building Program (HABP)	-0.340***	-0.247*	-0.403***
	(0.111)	(0.139)	(0.133)
PSNP Payment 2 years ago		0.033	0.029
		(0.087)	(0.047)
Drought 2 years ago		-1.720**	-1.473***
		(0.753)	(0.389)
PSNP Payment * Drought 2 years ago		0.374**	0.244***
		(0.174)	(0.095)
PSNP Payment 4 years ago			0.173**
			(0.067)
Drought 4 years ago			-0.053
			(0.470)
PSNP Payment * Drought 4 years ago			-0.152
			(0.124)

Source: Analysis by authors of PSNP survey rounds.
Observations: 7,075. Standard errors in parentheses. * p<0.10, ** p<0.05, *** p<0.01.

Supplementary Table 5. Months food secure – Poisson ML estimator with fixed effects

	(1)	(2)	(3)
PSNP Payment	0.001*	0.001**	0.001**
	(0.001)	(0.001)	(0.001)
Drought in past year	-0.143***	-0.147***	-0.165***
	(0.015)	(0.015)	(0.017)
PSNP Payment * Drought in past year	0.002**	0.002**	0.002*
	(0.001)	(0.001)	(0.001)
PSNP Payment 2 years ago		0.002***	0.002***
		(0.001)	(0.001)
Drought 2 years ago		-0.030**	-0.049***
		(0.013)	(0.015)
PSNP Payment * Drought 2 years ago		0.001	0.001
		(0.001)	(0.001)
PSNP Payment 4 years ago			0.001
			(0.001)
Drought 4 years ago			-0.034**
			(0.015)
PSNP Payment * Drought 4 years ago			-0.002
			(0.002)

Source: Analysis by authors of PSNP survey rounds.
Observations: 8,005. Standard errors in parentheses. * p<0.10, ** p<0.05, *** p<0.01.

Supplementary Table 6. Months food secure – Poisson ML estimator with instrumental variables

	(1)	(2)	(3)
PSNP Payment	-0.007	-0.005	-0.001
	(0.005)	(0.005)	(0.005)
Drought in past year	-0.387***	-0.333***	-0.284***
	(0.064)	(0.077)	(0.079)
PSNP Payment * Drought in past year	0.030***	0.022***	0.014
	(0.007)	(0.009)	(0.011)
PSNP Payment 2 years ago		-0.008	-0.017*
		(0.011)	(0.010)
Drought 2 years ago		-0.193***	-0.240***
		(0.052)	(0.054)
PSNP Payment * Drought 2 years ago		0.030***	0.042***
		(0.011)	(0.011)
PSNP Payment 4 years ago			0.007
			(0.012)
Drought 4 years ago			0.058
			(0.099)
PSNP Payment * Drought 4 years ago			-0.043
			(0.032)

Source: Analysis by authors of PSNP survey rounds.
Observations: 8,005. Standard errors in parentheses. * p<0.10, ** p<0.05, *** p<0.01.

Supplementary Table 7. Instrumental Variable (IV) model, using a detrended measure of food security

	(1)	(2)	(3)
PSNP Payment	0.012	-0.036	-0.092***
	(0.039)	(0.040)	(0.020)
Drought in past year	-1.871	-2.683***	-3.972***
	(1.176)	(0.319)	(0.510)
PSNP Payment * Drought in past year	0.187	0.383***	0.507***
	(0.185)	(0.085)	(0.113)
PSNP Payment 2 years ago		-0.229***	-0.226***
		(0.043)	(0.065)
Drought 2 years ago		-1.646***	-1.500***
		(0.481)	(0.565)
PSNP Payment * Drought 2 years ago		0.384***	0.309***
		(0.122)	(0.119)
PSNP Payment 4 years ago			0.045
			(0.109)
Drought 4 years ago			-1.189*
			(0.631)
PSNP Payment * Drought 4 years ago			0.141
			(0.167)

Source: Analysis by authors of PSNP survey rounds.
Observations: 8,005. Standard errors in parentheses. * p<0.10, ** p<0.05, *** p<0.01.

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About ESSP

The Ethiopia Strategy Support Program is an initiative to strengthen evidence-based policymaking in Ethiopia in the areas of rural and agricultural development. Facilitated by the International Food Policy Research Institute (IFPRI), ESSP works closely with the government of Ethiopia, the Ethiopian Development Research Institute (EDRI), and other development partners to provide information relevant for the design and implementation of Ethiopia's agricultural and rural development strategies. For more information, see http://www.ifpri.org/book-757/ourwork/program/ethiopia-strategy-support-program; http://essp.ifpri.info/; or http://www.edri-eth.org/.

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