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General equilibrium impact assessment of the Productive Safety Net Program in Ethiopia

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Glossary

Kebele. A *kebele*, part of a *woreda*, is the smallest unit of local government in Ethiopia, equivalent to a ward or neighborhood. *Kebeles* vary in size and can be home to anywhere from a few hundred to several thousand households.

Woreda. A *woreda* is an administrative division in Ethiopia (managed by a local government), equivalent to a district. There are about 700 *woredas* in Ethiopia, with an average population of about 100,000. *Woredas* are composed of a number of *kebeles*, or neighborhood associations (23 *kebeles* per *woreda* on average).

Executive summary

Ethiopia has long suffered from chronic food security issues, most dramatically revealed in the tragic 1983–1984 famine. The Productive Safety Net Program (PSNP) was designed as a large-scale and long-term coordinated effort to fight food insecurity throughout the country. The program, launched in 2005, falls in the ‘cash for work’ category: poor members of the community can receive small transfers in exchange for working on projects in their community. It is the largest program of its kind in Africa, reaching more than 8 million Ethiopians, about 10 per cent of the population.

The dual nature of the PSNP, combining the delivery of safety net protection with the creation of productive assets in the community, means that its impacts are multifaceted, as are the channels through which they operate. At the same time, it has the potential to profoundly affect the agro-ecology of targeted areas.

The impacts of the PSNP have been insufficiently studied. Research has focused on the benefits the cash or food transfer has provided to its recipients. We know very little about whether the PSNP has done anything to spark local economic growth, i.e. whether the broader ‘productive’ goal of the PSNP has met with any success. The PSNP might stimulate growth by loosening investment constraints in beneficiary households, but could also do so through local income multipliers and the creation of public goods (for instance, irrigation, land conservation) that lead to productivity gains, which in turn can create local income multipliers of their own. Past studies have not addressed impacts beyond the beneficiary households.

This report is part of an extensive effort to fill this lacuna. We aim to evaluate the impacts of the PSNP beyond the recipients of the cash transfer, both in terms of the local spillovers created by the cash transfer and the impacts of community assets on the local, regional, and national economies. The goal of the project is to apply a comprehensive micro-macro approach to evaluate the full impact of the PSNP. We develop a methodology bridging case studies, econometric evaluations, modeling and simulation approaches to capture the local economic linkages, identify the causal chains in program impacts, and evaluate the full impact of the program at the local and national scales.

Case studies allow us to capture context-specific variations in the implementation of PSNP projects on the ground, and a window into the corresponding impact channels. We studied eight *kebeles* in depth (two in each of four *woredas*). In each *kebele* we administered a PSNP-focused community survey and a business survey, and visited the sites of 21 different PSNP projects. Case study analysis suggests that soil and water conservation projects improve agricultural yields and increase availability of water for cattle. Tree projects participate in the conservation of soil and water, while also providing construction materials and business opportunities. Irrigation projects improve yields and allow high-value crops to be grown.

To build upon case study insights, we use econometrics to precisely estimate the average size of project impacts and demonstrate causality. We find a 2.8 per cent increase in grain yields that is statistically significant at the .01 level. This impact is interpreted as an average yearly effect in the zones in which a soil and water

conservation project was implemented. We also estimate that PSNP irrigation projects lead to 12 per cent growth in vegetable yields on a per-project basis.

Yield growth resulting from the PSNP, in turn, can lead to economic growth, a process that we simulate using an economy-wide model. We couple this with simulations of a transfer to eligible households (estimated to be 18 per cent of their income). This provides a simulation estimate of the simultaneous impacts of the productive and safety net components of the PSNP.

At the local scale, we use a local economy-wide impact evaluation (LEWIE) model to simulate the PSNP and evaluate its local economy-wide impacts (Taylor and Filipski, 2014). Eight LEWIE models (one for each *kebele*) reveal substantial local economy-wide impacts of the PSNP, with income and production multipliers of up to 2.4 Ethiopian Birr (ETB) per ETB transferred. Nevertheless, the program multipliers vary considerably across locales, and they can include both positive and negative spillovers for non-recipient households. Spillover size is determined by the structure of each local economy, the types of activities households engage in, and in particular the degree to which the community is integrated with outside markets.

Although the target *kebeles* are remote, their economies are not completely isolated from the rest of the country. This means that some of the benefits of the PSNP spill out of the *kebele* and into the rest of the country, for instance through trade, such as when beneficiary households purchase items outside of their *kebele*. Given the scale of the program, the aggregation of all these spillovers can be large enough to impact national markets. Therefore, we also conduct simulations at the Ethiopia-wide scale.

Simulating the PSNP at the national scale with a computable general equilibrium model reveals that the program creates sizeable nationwide spillovers. This reflects the unusual size and scope of the PSNP, the largest program of its kind in Africa. While PSNP areas see the largest income benefits in percentage terms (6 per cent of household income), the rest of the country experiences real income benefits of up to 2 per cent as a result of the PSNP’s impacts on supply, demand, wages, and prices. We find that the program increases national value added by 0.99 per cent.

This comprehensive approach to evaluating the impacts of the PSNP suggests that the effects of the program beyond the recipient households are far from negligible. Recognizing the broader impacts of the PSNP can change the way we evaluate and think about the economic costs and benefits of the program.

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Abbreviations and Acronyms

GMM	Generalized methods of moment
LEWIE	Local economy-wide impact evaluation
PSNP	Productive Safety Net Program
SAM	Social accounting matrix

1. Introduction

Ethiopia has long suffered from chronic food security issues, most dramatically revealed in the tragic 1983–1984 famine. The Productive Safety Net Program (PSNP) was designed as a large-scale and long-term coordinated effort to fight food insecurity throughout the country, contrasting with a previous strategy based on ad hoc emergency assistance (Gilligan, Hoddinott, and Taffesse, 2009). The program, launched in 2005, broadly falls in the 'cash for work' category: poor members of the community can receive small payments (in cash or sometimes in kind) in exchange for working on projects in their community. The PSNP is the largest program of its kind in Africa, reaching more than 8 million Ethiopians or about 10 per cent of the population (Sabates-Wheeler and Devereux, 2010).

The PSNP represents a two-pronged approach to addressing food security issues (illustrated in Figure 3, to which we will return). The 'safety net' component directly addresses the issue by targeting the poorest segments of the population and providing them with a source of income or food. The program emphasizes exit out of poverty, and beneficiary households can graduate into a different program once they are deemed to be at lower risk of food insecurity. The 'productive' component entails stimulating the local economy as a whole by building community assets such as soil and water conservation (SWC) structures, roads, schools, etc. This second component relies on more fundamental changes to the productive and economic environment, such as improving productivity or facilitating market access. These impacts develop at the local economy-wide scale, involve many actors interacting on local markets, and may unfold over the medium to long run. Both the safety net and productive components of the PSNP participate in a broader ultimate goal, which is to foster economic growth in the target area.

The safety net component of the PSNP has been studied to some extent. Household incomes in beneficiary households are tracked, and graduation rates are collected and regularly reported from each PSNP location in a standard fashion. A few econometric studies have looked at additional benefits in recipient households, such as schooling or resource use (Andersson, Mekonnen, and Stage, 2011; Hoddinott, Gilligan, and Taffesse, 2009). These studies help us understand the benefits that the cash or food transfer has provided to its recipients.

On the other hand, we know very little about whether the PSNP has done anything to spark local economic growth, i.e. whether the broader 'productive' goal of the PSNP has met with any success. The PSNP might stimulate growth through income multipliers created by cash transfers and/or by achieving productivity gains, which in turn can create local income multipliers of their own.

This report is part of an extensive effort to fill this lacuna. We aim to evaluate the impacts of the PSNP beyond the recipients of the cash transfer, both in terms of the local spillovers created by the cash transfer and the impacts of community assets on the local, regional, and national economies. The goal of the project is to apply a comprehensive micro-macro approach to evaluating the full impact of the PSNP. We develop a methodology bridging case studies, econometric evaluations, modeling and simulation approaches to capture the local economic linkages, identify the causal chains in program impacts, and evaluate the full impact of the program at the local and national scales.

The case study component provides in-depth analysis of four *woredas* (with two *kebeles* in each) and gives us insights into the types of benefits experienced in PSNP communities, as well as the challenges. Those case studies provide the background to inform the choices we make in the econometric and modeling parts of the evaluation.

The econometric component of our analysis relies on a four-year panel data and a fixed effects instrumental variables (IV) specification to estimate the impacts of certain types of PSNP projects on yields. With this estimation strategy, significant regression coefficients are revealing a causal link between the projects and yield growth. We thus generate rigorous evidence that the public works component of the PSNP has an impact on local agriculture. We then integrate those results into economy-wide models to further evaluate the local impacts of the program.

The modeling components of the analysis rely on two types of general equilibrium modeling approaches at different scales: a local economy-wide impact evaluation (LEWIE) model (Taylor and Thome 2012; Thome et al. 2013; Taylor and Filipski 2014) and a computable general equilibrium (CGE) model (Löfgren, Robinson, and Harris, 2002). The models are similar in spirit, but the former focuses on small-scale impacts within local economies, while the latter is applied at the national scale. Both are simulation approaches tailored precisely towards the goal of capturing the higher order impacts of economic shocks. The simulations we run are informed by the case study and econometric components of the evaluation, ensuring that we are modeling the likely causal impacts of PSNP projects. By using models at both the local and the national scale, we are able to offer a more comprehensive picture of the breadth of PSNP impacts.

The remainder of this report is organized into the following sections: (2) a background section presenting the PSNP and its theory of change; (3) motivation and outline of our evaluation strategy; (4) data and methodology; (5) to (8) four types of results: case study evaluation, econometric evaluation, LEWIE modeling evaluation, and CGE modeling evaluation; (9) a discussion of results; and (10) specific findings for policy and practice.

2. Intervention, theory of change, and research hypotheses

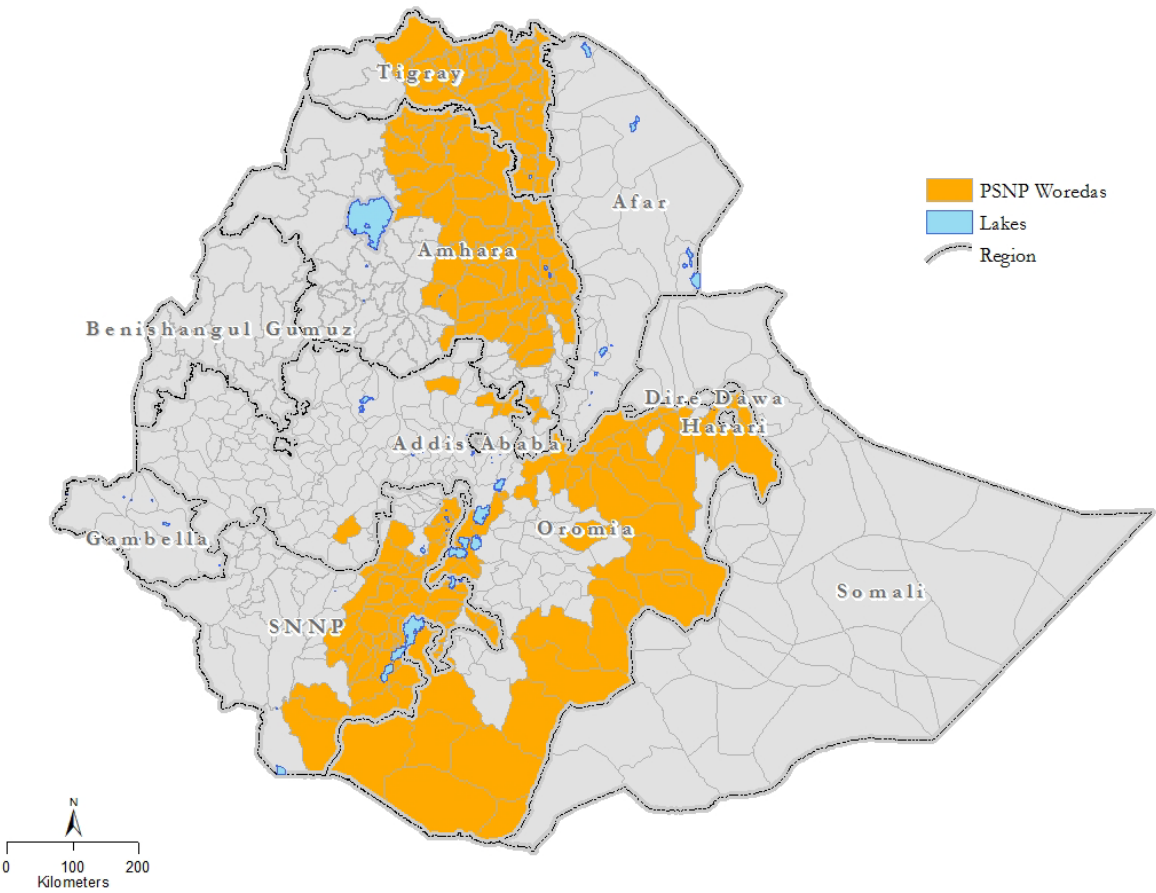
The PSNP is a nationwide program, active in rural areas that were classified by the government as chronically food insecure, based on the frequency with which they have required food assistance in the recent past.[1] The program was gradually extended to cover 262 chronically insecure *woredas* (Ethiopia is divided into about 690 *woredas*), spread across the four regions of Tigray, Amhara, Oromia, and SNNPR (Southern Nations, Nationalities, and People's Region).[2] All *kebeles* in a selected *woreda* are eligible for PSNP funding. In each *kebele*, selected households are eligible for transfers (cash or kind), which can be either conditional (public works) or not (direct support). The

[1] The details of this criterion have evolved slightly over the PSNP's 10 years of existence, as has the number of eligible *woredas*.

[2] After 2009, it was also extended to pastoral areas in the Somali and Afar regions, with specificities adapted to semi-nomadic populations.

public works component of the PSNP grants transfers to beneficiaries conditional on work. The direct support component grants the same benefits without any work requirement. The latter was implemented for those eligible households with no able-bodied adult members, who are thus unable to participate in the public works effort. Direct support beneficiaries represent 16 per cent of the total. A map of the PSNP regions is shown in Figure 1.

Figure 1: Map of PSNP *woredas* in the regions Tigray, Amhara, Oromia, and SNNPR



2.1 PSNP implementation

The household eligibility criteria focus primarily on chronic food insecurity and asset holdings. Households are deemed eligible if they have repeatedly faced a long period of food shortage (food gaps lasting more than three months) during the past three years, or if they repeatedly received food assistance in the three years before the start of the program. They can also gain eligibility if they have suffered a severe loss of assets or a severe chronic disease in the more recent past (1–2 years). Those criteria are implemented with some flexibility: the general state of a household's asset holdings, ability to benefit from social protection through family support, and particular vulnerabilities such as single parenthood or high dependency ratios are also taken into account.[3] To ensure that the correct people are included in the program, households are not selected based on survey data but rather by a committee of peers within their village, who are most able to identify who in their community is food insecure (GFDRE 2010).

Eligibility is reassessed every year. Previously ineligible households can become eligible if they are deemed unable to meet their food requirements. Conversely, current beneficiary households who are redefined as food sufficient lose eligibility, or graduate from the PSNP. Households lose eligibility if it appears they would be able to meet their food requirements *even after* they potentially stop receiving PSNP support. For that reason, graduation decisions are based on asset holdings (for example, land holdings, food stocks, livestock), which are likely to reflect a household's ability to sustain its food intake and withstand shocks in the future. To determine which level of assets corresponds to a situation of food security, regional benchmarks for asset holdings are provided each year by the government as guidelines for re-targeting. However, these benchmarks are also applied with a certain degree of flexibility. Households that graduate from the PSNP become eligible for the Household Asset-Building Program, which helps them make productive investments (GFDRE 2010).

Once a household meets the eligibility criteria for the PSNP, all of its members become beneficiaries. Those able to work must then participate in the public works. Young, elderly, disabled, or ill members are exempt from working, as are pregnant or lactating women. Each beneficiary can only work for five days per month on the public works, so that beneficiaries can engage in other income-generating activities or fulfil other obligations. The works are also limited to the first half of the calendar year, so as not to conflict with the harvest season.

The institutional arrangements of the PSNP are highly decentralized. *Kebeles* are exclusively rural areas and tend to encompass several villages. Beneficiaries for the PSNP are selected at the village or community level (which is not a formal administrative division). They are chosen from within a community by a task force which is composed of a dozen members, including elected male, female, elder, and youth representatives, as well as one development agent, one health extension agent, and one representative from the *kebele*.

The task force also submits project plans to the decision-making body at the *kebele* level: the Kebele Food Security Task Force (KFSTF). The KFSTF is the main decision-making body when it comes to planning and implementing public works, which is why we conducted a community survey at the *kebele* level as part of this evaluation. The KFSTF works on project plans in collaboration with each community and turns those plans into *kebele*-wide proposals. Review and funding of proposals is controlled at the *woreda* level by the Woreda Food Security Task Force. Approved and financed projects are implemented and overseen on the ground by the KFSTF (GFDRE 2010).

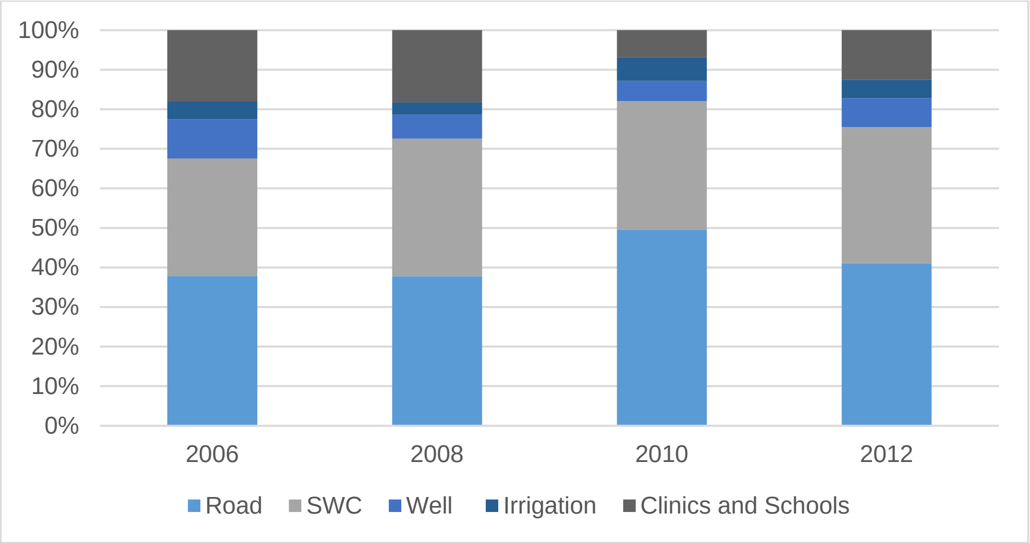
The general requirement for projects to be funded under PSNP is that they provide public benefits. Examples of public works include physical conservation structures (terraces, bunds), community roads, dams, ponds, wells, springs, irrigation structures,

[3] There has been a certain amount of debate around whether the PSNP eligibility criteria have indeed been implemented as planned and the effectiveness of the targeting and graduation mechanisms (Coll-Black et al. 2013; Sharp et al. 2006).

tree nurseries, or buildings such as schools, farmer training centers, and clinics. They are usually implemented on public land, but private land may be used as long as community benefits are expected. Again, the decentralized institutional arrangements allow a certain degree of flexibility in terms of project planning and implementation.

Figure 2 shows the distribution of the types of projects implemented by PSNP since its inception. Despite small year-to-year variations, the project mix has remained fairly consistent through the years: roads and SWC projects are the most popular, followed by building schools or clinics, wells, and irrigation. Such projects have the potential to create benefits for the whole community.

Figure 2: Distribution of project types by year (new projects only, not maintenance)



Source: EFSS dataset.

2.2 Theory of change and research hypotheses

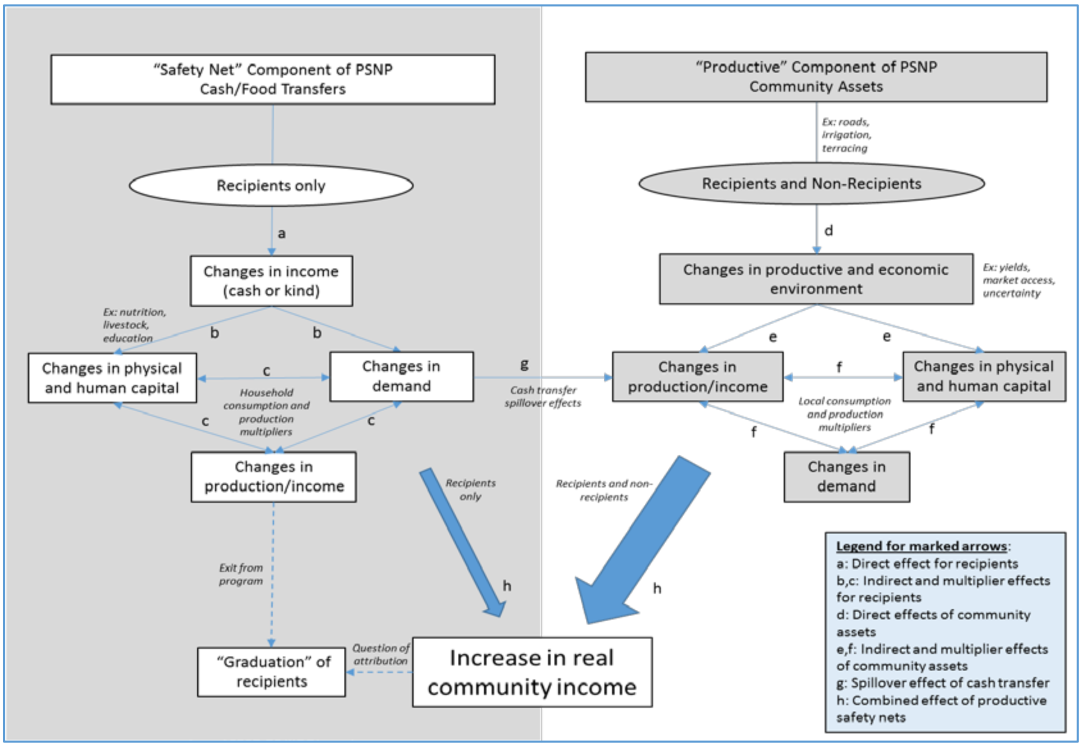
The PSNP set out with an ambitious goal: to provide income in cash or kind to the poorest rural households, while at the same time creating community assets that enhance local productivity and stimulate development in the long run. By providing poor households with new income opportunities, the program influences consumption demand and economic behavior in the beneficiary households. Public works projects supported by the PSNP potentially benefit non-beneficiaries as well as beneficiaries, by raising productivity.

Both the increased consumption of beneficiary households and the increased productivity resulting from public works projects potentially set in motion local income multipliers. Beneficiary households spend part or all of their income on locally supplied goods and services. Increased productivity also affects the local supply of goods and services, the incomes of non-beneficiaries as well as beneficiaries, and local prices. These, in turn, potentially unleash additional rounds of income and production growth in the local economy. Ultimately, benefits leak out of local economies, potentially stimulating growth elsewhere in the Ethiopian economy. The impacts captured by our analysis depend on how widely we cast our analytical net, which is why in this study we focus on both the local and national levels.

The theory of change for this two-pronged offensive against food insecurity is illustrated in Figure 3. On the left of the figure, the safety net component provides assistance in cash or kind to beneficiary households (either as remuneration for public work, or as direct support – arrow [a] in the figure). The main goal of the safety net component is to ensure that the eligible households are able to meet their food requirements. At first, the transfer itself provides the households with food or with financial means to obtain it (arrow [a]), but in the long run it is expected that the household will graduate from the program once it is deemed that the household would be capable of meeting its food needs without the program.

This expectation assumes that the transfer will trigger positive changes at the household level, beyond simply increasing income. Whether in cash or in kind, the transfer relieves the household cash constraint, allows capital investments in physical capital, and bolsters human capital through improved nutrition levels (arrows [b]). It also reduces uncertainty about future streams of income, which can promote productive investments. As such, transfer income can trigger a virtuous circle of consumption and production multipliers within the household, represented by arrows (c). The household gradually accumulates assets, increases its productive capacity and production volumes, engages in more income-generating activities, and ultimately is able to secure its own consumption (and graduate from the program). Improved incomes in the beneficiary households contribute towards the broader goal of local growth (smaller arrow [h]); however, the real transformative changes on that front are expected to result from the second component of PSNP, the productive one.

Figure 3: Direct and indirect channels of impact of the PSNP on household and community incomes



The right side of Figure 3 illustrates how the productive component of the PSNP potentially builds community assets. These affect everyone in the target localities, both cash recipients and non-recipients (arrow [d]). The ultimate goal of this component is to generate growth at the local scale; that is, to increase real incomes in the community. The theory of change starts with the (potential) fundamental enhancements brought to the local productive or economic environment by the community asset. Those enhancements include (but are not limited to) improving access to markets, raising agricultural yields, and reducing risk. One goal of this project is to document the existence, variety, and extent of these changes.

This improved environment is expected to have productive impacts. For instance, farmers have better quality land, produce higher output, and are able to sell it on the market at better prices (arrows [e]). This also triggers a virtuous circle of consumption and production multipliers (arrows [f]), this time not just within households but at the local economy-wide scale. The safety net component also contributes somewhat to this virtuous circle, through beneficiaries' increased demand for goods and services. For instance, a beneficiary household may spend its cash transfer on crops sold by non-beneficiary neighbors (arrow [g]). Together these economy-wide multipliers can result in income growth at the local and regional level (arrows [h]).

Despite the systemic and far-reaching nature of the potential impacts of PSNP, almost all evaluation has been limited to impact on the treated. The PSNP tracks graduation rates as a measure of success of the program, which primarily captures the effectiveness of the safety net component, but fails to capture potential benefits beyond the beneficiaries. The hypothesis behind our undertaking is that the PSNP has had measurable impacts beyond the cash transfer beneficiaries, which we can reveal with a more complete evaluation approach. This approach involves combining case studies, econometrics, and modeling and simulation frameworks to provide an assessment of the full impact of the PSNP, both within a local economy and at the national scale.

3. Evaluating the full impacts of the PSNP

3.1 State of knowledge

The evaluation method currently considered to be the gold standard relies on randomized controlled trial (RCT), a methodology inspired by experimentation in the life sciences. In an RCT design, eligible populations are surveyed before treatment, then the treatment is allocated to some (but not all) of the eligible group, and this allocation is done in a randomized fashion. Populations are then re-surveyed after a given period of time, and the change between pre-treatment and post-treatment is calculated for any outcome of interest. The randomization ensures that any difference in the way the treated and control populations evolved between pre- and post-treatment data collection (or the 'difference-in-difference') is attributable to the treatment itself.

Unfortunately, only very few types of interventions can be evaluated in this fashion, and the PSNP is not one of them. First, the PSNP is not allocated randomly (for good reason): it is implemented in all of the most food-insecure *woredas*, where the poorest segments of the population become eligible for cash transfers. Thus there does not exist a group of 'control' households in the RCT sense, who are eligible for the PSNP but were randomly allocated not to receive it. Second, the “PSNP treatment” is not uniform across target areas. Rather, local communities decide on which project to implement in accordance with local needs. Some communities build roads, others plant trees or dig irrigation canals, but that decision is (thankfully) not taken at random. The amount of financing also varies with the type and size of the project. Finally, but importantly, there was no baseline data collected before the implementation of the PSNP, precluding a difference-in-difference approach.

The absence of a feasible randomization design does not mean we cannot evaluate the impacts of the PSNP. The safety nets component in particular, which distributes cash or food to easily identifiable recipient households, may be somewhat less challenging to evaluate than the broader productive component. Surveys can track outcomes of interest in beneficiary and non-beneficiary households, and a variety of econometric techniques can be used to determine whether receiving PSNP payments improves incomes, nutritional intake, school attendance, or other indicators of quality of life (arrows [a], [b], and [c] in Figure 3). The major challenge in this type of evaluation is to control for selection – that is, differences between PSNP participants and non-participants that might influence outcomes of interest, independent of the program’s impacts. To avoid this pitfall, researchers rely on econometric methodologies such as nearest neighbor matching, propensity score matching, or dose-response models.

This line of research, while it has by no means been exhaustive, has yielded a number of encouraging results, some of them summarized in Table 1. Studies have suggested that the PSNP has been rather successful at providing relief for its beneficiaries, by reducing food insecurity (Gilligan et al. 2009) and raising agricultural yields (Hoddinott et al. 2012). PSNP participants are more likely to plant trees (Andersson et al. 2011), which helps curb deforestation. They are less likely to rely on child labor (Hoddinott et al. 2009). Nevertheless, these findings fall far short of covering all the potential impacts underlying arrows (a), (b), and (c) in Figure 3. More research is needed to continue disentangling the impacts of PSNP cash transfers on beneficiaries over the PSNP’s 10 years of existence.

Table 1: PSNP impact evaluation in the literature

	Authors and year	Sources or years of data	Methodology	Scope	Overall results
1	Gilligan et al. 2009	2006	Nearest neighbor matching	Beneficiaries only	Positive impacts of PSNP and Household Asset Building Program (HABP) on food security and a range of economic outcomes.
2	Hoddinott, Gilligan, and Taffesse 2009	2006	Nearest neighbor matching	Beneficiaries only	PSNP reduces reliance on child labor; no impact on school attendance.
3	Andersson, Mekonnen, and Stage 2011	2002, 2005, 2007	First-difference regression	Beneficiaries only	PSNP leads to increased tree-planting, but no reduction in reliance on forest.
4	Hoddinott et al. 2012	2006, 2008, 2010	Dose-response models; propensity score matching	Beneficiaries only	PSNP payments help improve the use of fertilizer and investments in agriculture, but only in combination with HABP program.
5	Berhane et al.	2006, 2008, 2010	Difference-in-difference; dose-response model	Beneficiaries only	PSNP improves food security and increases livestock holdings.
6	Debela, Shively, and Holden 2015	2006, 2010	Exogenous switching regression	Beneficiaries only	Positive short-term nutritional benefits for children.
7	Woldehanna 2010	Young Lives data	Propensity score matching	Beneficiaries only	Public works program improves child outcomes related to education (study time, child labor, grade attainment).
8	**Present study**	2006, 2008, 2010, 2012	Mixed methods (econometrics + modeling)	Economy-wide	PSNP has positive impacts on yields and incomes beyond the cash recipients alone.

In addition, all the currently published literature that we know of focused only on the impacts of the PSNP on the safety net recipients. Yet the PSNP has much broader goals than just providing a safety net to its beneficiaries. It was designed to address the fundamental roots of the food security problem through its public works component, as illustrated by the requirement that projects have community benefits. Curbing erosion, conserving water, preventing floods, and building roads and schools all lead to community-wide impacts. Up until now, no study has attempted to rigorously evaluate any of these impacts. In other words, we know almost nothing about arrows (d) to (h).

To complicate matters, these impacts potentially affect everyone in the economy indirectly, both the recipients of the cash transfer and the non-recipients. If projects change the agro-economic environment in a *kebele*, the size and scope of this impact potentially dwarfs the direct effect of the cash transfer on the program's recipients. To really evaluate the success of the PSNP, it is crucial to understand the role of PSNP-created community assets.

Community benefits are much harder to evaluate and attribute than private benefits to recipients. The beneficiaries are many and are not always clearly defined, such as when projects affect the hydro-ecology of an area. The benefits may unfold over the long run and affect many interrelated aspects of the rural development process. The essential question we need to answer is whether the PSNP, through its safety net and public works programs, helps provide an environment which fosters development and enables economic growth. In other words, can we find any indication that arrows (d), (e), (f), and (h) in Figure 3 are materializing on the ground? There are many facets to this question, as it involves a plethora of interrelated ecological and economic factors. In the absence of feasible randomized controlled evaluation, we need to take a more systemic approach, bridging qualitative and quantitative methods.

3.2 Evaluation questions

Given the current limited understanding of the full impacts of the PSNP, this study was designed to extend the evaluation of the PSNP in two directions: (1) assessing the spillover effects of the PSNP transfers on the local and regional economies; and (2) evaluating the impact of community assets built on both beneficiary and non-beneficiary households and, more broadly, on the local economy as a whole.

Three evaluation questions were designed along these two directions:

1. What are the contributions of community assets developed through the PSNP on both beneficiary and non-beneficiary households, as well as on the community as a whole, and what are the main channels of such contributions?
2. What is the local spillover effect of the PSNP, what are the key factors (which are often not considered part of the PSNP) critical in enhancing the spillover effect of the PSNP, and how can such an effect be correctly measured?
3. What is the aggregate national spillover effect of the PSNP when the program has been implemented in more than 260 *woredas* across four regions, and what are the other key policy factors that will effectively increase such spillover effects?

3.3 A four-pronged comprehensive approach to PSNP evaluation

Given the central position of the PSNP in Ethiopia's rural development strategy, as well as its financial cost, it is imperative that we evaluate it in ways that address its potentially substantive economy-wide impacts. With that aim, we developed a comprehensive framework to study those impacts, with analysis tools at the micro, meso, and macro scales. The four-pronged framework includes case studies, econometric analysis, local economy-wide modeling, and country-wide CGE modeling.

Figure 4 shows how we combine the four analysis tools in this evaluation.

Case studies. First and foremost, we rely on case studies of PSNP locations to provide us with a contextualized idea of the breadth, depth, and diversity of PSNP interventions and impacts. We rely extensively on data gathered from case studies in the context and program design sections of this report. Beyond that, such in-depth studies allow us to gain insight into the local mechanics of PSNP impacts, and inform our quantitative analyses every step of the way.

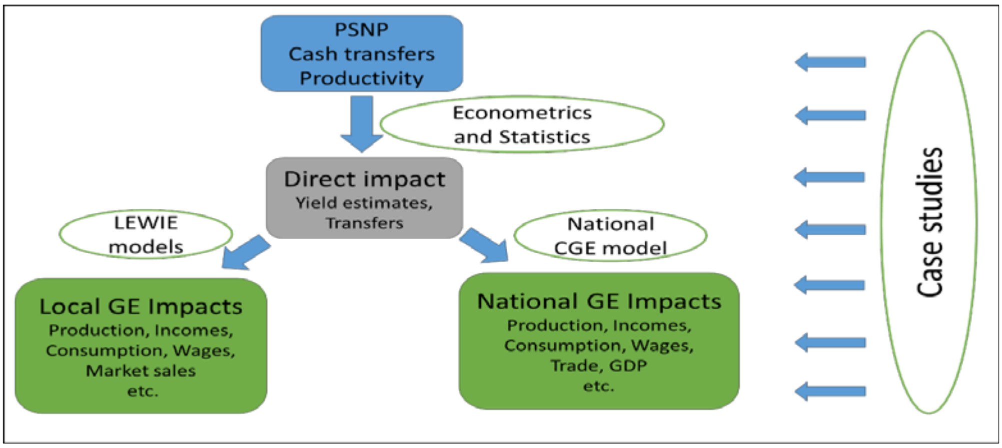
Econometrics. Having observed and documented the likely impacts of PSNP public works projects in our case studies, we then use econometric evaluation to test whether these impacts are materializing in the data and estimate their size and significance. Thanks to the panel nature of the PSNP dataset, we can employ econometric techniques that solve the problem of attribution, meaning that we can state with relative confidence that the estimated impacts are due to the PSNP. The results obtained not only provide hard numerical evidence of the impacts of PSNP projects but also lay the ground for modeling and simulation analysis.

LEWIE modeling. The third part of the framework takes the analysis to the meso level with LEWIE modeling. This type of modeling was designed to simulate the way a program or policy affects all the actors in a local economy, beyond the targeted households themselves. While econometrics help us estimate the average first order impacts of project implementation on yields and incomes, by feeding them into a LEWIE model we can get a sense of the ensuing second order, or "general equilibrium," impacts that arise through market linkages.

CGE modeling. The last part of the framework takes our analysis to the national scale, with a CGE model for Ethiopia. The PSNP covers about 10 per cent of Ethiopia's population and one third of all *woredas*: at this scale, it is likely to have non-trivial impacts on markets and on the national economy. In the final part of the evaluation, we use modeling and simulation at the macro scale to evaluate how the impacts we estimated econometrically for the PSNP communities may be affecting the national economy in the aggregate.

Our methodology thus combines analysis that is nationally representative with analysis that is locally detailed. Our econometric strategy is based on a representative sample of all PSNP areas at the national scale. The CGE analysis, similarly, provides nationally representative simulation results. On the other hand, the case studies and LEWIE models are based on in-depth assessment in eight *kebeles*. Rather than national representativeness, these tools are meant to lend nuance to our analysis, by showcasing the diversity of settings and impacts.

Figure 4: Four-pronged evaluation strategy of the economy-wide effects of the PSNP



By combining both qualitative and quantitative, micro and macro approaches, we generate a more complete picture than previous analyses focusing only on recipient outcomes or graduation. This analysis shows that the PSNP does indeed have far-reaching effects beyond the beneficiaries themselves, and that ignoring its productive component may be dramatically underestimating the impact of the program.

4. Data sources

This section describes the data we rely on for our evaluation, and the details of our methodology for each of the four analysis components. Each of the four components has specific data requirements, and we satisfy them by drawing from a wide range of sources.

4.1 The Ethiopian Food Security Survey dataset

The study makes extensive use of the Ethiopian Food Security Survey (EFSS), a four-wave longitudinal quantitative household and community survey administered every two years from 2006 to 2012. The surveys were carried out by the Ethiopian Central Statistical Agency in collaboration with the International Food Policy Research Institute (IFPRI). The sampling of the household survey was carried out in multiple stages. First, *woredas* were chosen from each of the four regions in which the PSNP was launched (Tigray, Amhara, Oromiya, and SNNPR).[4] *Woredas* were sampled with probability proportional to size; that is, a certain number of food-insecure *woredas* were drawn from each region in proportion to the overall number of chronically food-insecure *woredas* within that region and relative to the number of chronically food-insecure *woredas* in all four regions.[5] In the next step, *kebeles* involved with the PSNP were randomly selected within each *woreda*. The sample design includes two *kebeles* per *woreda* in Amhara, Oromiya, and SNNPR and three enumeration areas per *woreda* in Tigray. In each enumeration area, 15 beneficiary and 10 non-beneficiary households – a total of 25 households – were selected.

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[4] The Somali region later also became part of the PSNP, but data was not collected in that region.
[5] A household is considered chronically food insecure if it had three or more months of unmet food needs per year in each of the preceding three years (GFDRE 2006).

Data for all rounds was collected in the same period around June. The data was collected from 68 *woredas* in the first round and 78 *woredas* in the remaining rounds. Due to changes in the definition of *woreda* and enumeration area boundaries in 2012, for this study we only use 63 *woredas* in the first round and 77 *woredas* in the remaining rounds. In total, 2,227 households make up a balanced panel data over the four survey rounds; an additional 1,079 households in the last three rounds bring the total number of households to 3,306. The attrition rate in the sample between rounds is about 3 per cent (Berhane et al. 2013).[6]

The structure and content of the EFSS questionnaires remained largely unchanged across survey rounds and included: basic household characteristics, land and crop production, assets, non-agricultural income and credit, access to the PSNP and HABP, consumption expenditure, health, shocks, perceptions, and anthropometry. The household questionnaire was complemented by a questionnaire administered at the community (*kebele*) level, which covered the following topics: location and access, water and electricity, services, education and health facilities, production and marketing, migration, and wages. Importantly, the community survey also featured questions about operational aspects of the PSNP, including the composition of the Food Security Task Forces and the types of public works carried out. In addition, a price questionnaire obtained detailed information on prevailing food prices in each round.

4.2 Ethiopia social accounting matrix for 2005–2006

For the CGE modeling analysis at the national level, we used the social accounting matrix (SAM) for 2005–2006 published by the Ethiopian Development Research Institute (EDRI 2009). The year 2005 coincides with the start of the PSNP and therefore serves as a baseline.[7]

The SAM is a consistent database of all value flows in the economy during the 2005–2006 fiscal year, including production, consumption, investment, trade, and government balances. It features 238 accounts: 128 activities (86 regionally differentiated agricultural activities, 28 industrial activities, and 14 service activities), 68 commodities, 22 factor accounts, 12 household accounts, 3 types of taxes, transaction costs, savings-investment balances, stock changes, the government, and a "rest of the world" account for international trade.

This matrix is a great tool to perform simulation-based analyses of the Ethiopian economy. In order to apply it to a PSNP context, we need to regionalize it into PSNP and non-PSNP areas. Agricultural activities and households are already regionalized in the SAM according to agro-ecological zones. We make use of that structure to further disaggregate PSNP areas from non-PSNP areas. This process is described further in the results section.

[6] Berhane et al. (2013) have verified that being a beneficiary is not highly correlated with the probability of attrition.
[7] There exists a 2009–2010 SAM for Ethiopia. However, for this project we found that using a SAM for the earlier years of the PSNP would serve as a better baseline to simulate the contributions of the project.

4.3 Case studies and field visits

The evaluation started with case studies and field visits in eight PSNP *kebeles* (two in each of four *woredas*). Their goal was to gain an understanding of the variety of contexts in which the PSNP operates. This type of information is difficult to obtain from statistical or econometric analysis of data, which is concerned with averages. The second goal of the case studies was to obtain necessary data to perform a LEWIE modeling analysis for those *kebeles*.

4.3.1 Site selection

Our choice of *woredas* to study in depth was guided by several considerations. First, Ethiopia is a country with extreme heterogeneity in agro-climatic conditions, such that the public works undertaken as part of the PSNP are likely to present a high degree of variation. In order to capture some of this heterogeneity, we chose to collect data in one *woreda* of each of the four large regions where the PSNP is active. Second, in order to maximize our ability to rely on existing data, we restricted our selection to *woredas* for which we have access to complete information in the four rounds of household data in the EFSS. Third, we further narrowed down our choice to *woredas* where the PSNP had involved the largest numbers of soil conservation projects, irrigation projects, tree-planting projects, and road projects (as opposed to building schools or health centers). This is because these types of projects are directly geared to improving a locality's agro-ecology and market environment. These criteria narrowed down our choice to a few *woredas* in each region. Our final selection was driven by considerations of accessibility. The selected *woredas* are mapped in Figure 5.

Once we had selected the *woredas*, *kebele* choice was guided by the EFSS sample. The sampling strategy of the EFSS household data randomly selects two *kebeles* in each *woreda* where the PSNP is active, except in Tigray where it selects three *kebeles* per *woreda*. This made our selection of *kebeles* straightforward in the Amhara, Oromia, and SNNPR regions. In Tigray, we chose the *kebele* according to the number and nature of PSNP projects, as we had done for the *woreda* selection.

Field visits started with open-ended interviews at *woreda* level with members of the Woreda Food Security Task Force. We then visited each of the *kebeles* and conducted open-ended interviews with members of the KFSTF. All those interviews included a respondent consent form and were conducted in the local language (Amharic or Tigrinya) by a two-person team.

In each community, we also asked to visit the sites of each PSNP public works project. For each project we recorded information about when it was started and completed, whether any machinery was involved, and whether the community had received help from any third party to plan the project. In addition, we asked open-ended questions about whether any impacts of the project had manifested. We visited seven SWC projects, five road projects, four irrigation projects, and three wells or ponds, as well as two clinics and a school.

4.4 Business and community surveys in selected *kebeles*

Part of this analysis relies on case studies of eight selected *kebeles*. In those areas, we had the opportunity to complement the data from the EFSS. As we conducted site visits in each of the selected *kebeles*, we collected data with a more structured approach based on surveys: one *kebele* survey in the form of a group discussion with prominent members of the *kebele*, and a business survey targeting businesses of all sizes throughout each *kebele*. Both the community and the business survey are provided in the appendices.

Both questionnaires were designed with two goals in mind: to fill in the knowledge gaps about the impacts of PSNP projects on economic activity and market integration in target areas, and to complete the data requirements for the LEWIE modeling and simulation exercise. Both questionnaires are in-depth studies appropriate for context-specific research; they were designed on the basis of a short period of formative work in six out of the eight *kebeles* a few weeks prior to formal data collection. While the data collected with those surveys was also used to compute statistics, its main goal is not the accumulation of observations for statistical power but to provide us with a wealth of qualitative and contextualized information absent from standardized household data.

4.4.1 Community surveys

We conducted eight community surveys, one for each *kebele* selected for the case studies. The community questionnaire was filled via group discussion involving at least five people (seven on average), including official community leaders and people who may be knowledgeable about the community, such as elders, teachers, or priests. The group included at least one woman and at least one member of the KFSTF wherever possible. The survey collected detailed information on the nature and duration of all the public works that have taken place in the community under the PSNP umbrella. It then proceeded to record, for each type of public work, the different ways in which it influenced agricultural productivity, economic activity, or market integration in the community.

While the data collected in our *kebele* community survey relies on collective recall, many of the survey questions are factual and do not leave much room for uncertainty – for example, what type of vehicle is able to use a given road, whether or not a flood or drought has occurred, availability of health services, access or distance to nearest markets, and so on.

4.4.2 Business surveys

The business questionnaire targeted selected business owners in each of three categories: production, retail, and services. We collected an average of 30 business questionnaires in each *kebele*, though business activities are more common in some *kebeles* than in others.[8] We sought out business owners operating in permanent structures (such as shops, mills, or breweries), although in some *kebeles* there were very few: the maximum was about 20–30, while in Joro Geta we interviewed a dozen. In Kolet, we interviewed all permanent structure business owners: three shopkeepers, a miller, and a seamstress. We also went to the weekly markets to find respondents who do not have permanent structures for their business. At the markets we interviewed all types of traders, as well as farmers selling their harvest or livestock. Markets are usually structured into zones (for example, grain sellers, vegetable sellers), and we used this

[8] We consider all trade activities as ‘business’, thus including farmers selling their own crops. The goal of the survey is to understand trading networks, which is why we adopt this broad definition.

zoning to ensure we collected data representative of the variety of business types in the region.

Among the goals of this survey is to allow us to assess the degree to which community markets are integrated with regional and national markets. This information is particularly important in the case of markets for agricultural goods and labor markets, because those markets tend to shape many of the local general equilibrium effects we wish to uncover. Another goal is to find out whether the PSNP projects have influenced market dynamics in any way, either on the supply or the demand side. Respondents were asked specific questions about the locations where they do business, the roads they use for transportation, and some recall questions for those who were in business before the PSNP.

4.5 Additional secondary data

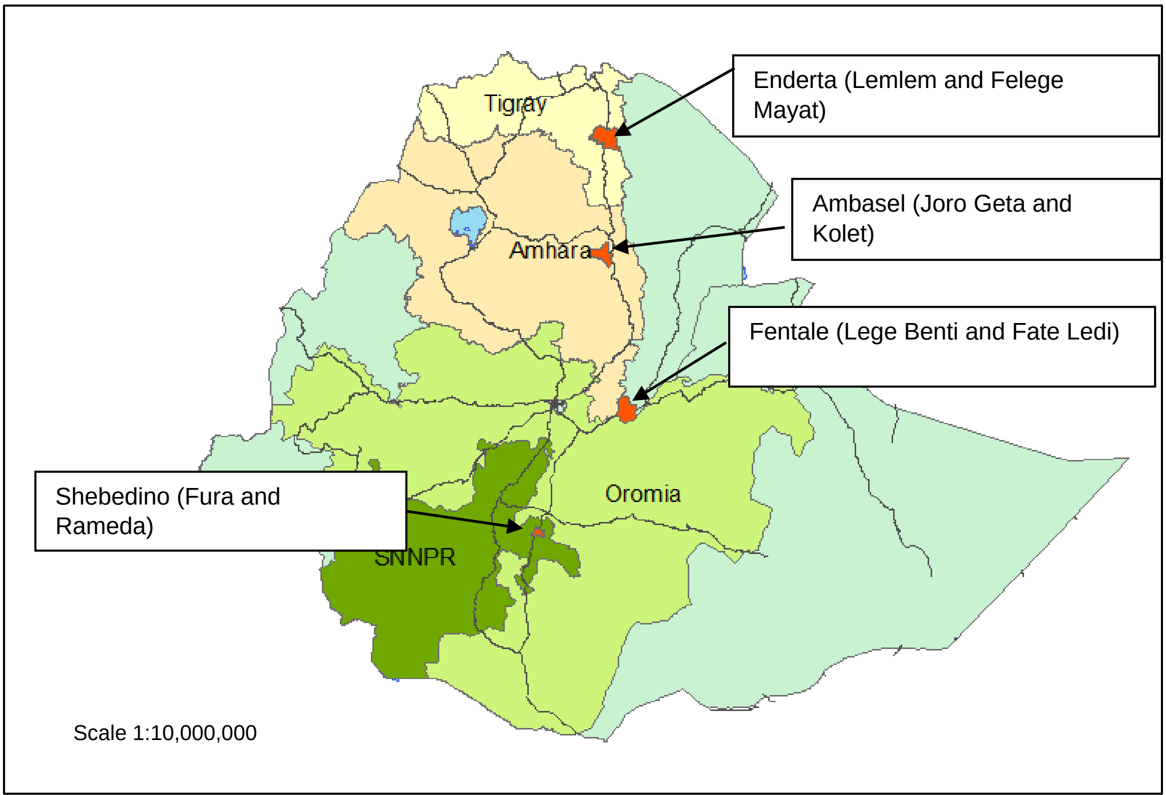
We performed the lion's share of our analysis based on the three sources of data described above. However, in particular instances we had to complement this with additional datasets. For maps, we obtained geographic information systems data from the Ethiopian Central Statistical Agency. For conversion values, we obtained exchange rate data from the National Bank of Ethiopia. In each of the eight case study *kebeles*, we obtained data on the numbers of PSNP beneficiaries by year and gender from the respective KFSTF.

5. Case study evaluation of PSNP impacts

In this section we use case studies to provide a contextualized picture of how PSNP benefits ripple through local economies. We collected detailed data from eight *kebeles* (two in each of four *woredas*). The information we gathered, in addition to illustrating the realities of the PSNP on the ground, was instrumental in shaping our econometrics and modeling work. We selected one *woreda* in each of the major PSNP regions. Each *woreda* captures a very different set of ecological and economic constraints. Together, they testify to the contextual diversity of PSNP settings. Figure 5 maps the locations of the four selected *woredas*. We also briefly describe them in the next section.

This section will first provide a comparison of the general characteristics of our study sites, then an overview of PSNP activities at those locations, and finally some case studies of PSNP projects in each location.

Figure 5: Map of Ethiopia with case study *woredas* (and *kebeles* in parentheses)



5.1 Four *woredas* with widely differing agro-ecologies

Table 2 presents some general information about the *woredas* and *kebeles* we selected.

5.1.1 Enderta – southern Tigray zone – Tigray region

Tigray is Ethiopia's northernmost region, bordering Eritrea. Though it is relatively arid and drought-prone, the amount of rainfall is sufficient to sustain agriculture, and Tigray relies primarily on crop production (unlike the Afar pastoralist region which neighbors Tigray to the east). Major crops are cereals (wheat, barley, teff), various legumes (lentils, beans) and, increasingly, vegetables (onions and peppers).

Enderta is located in the southern Tigray zone, near the regional capital Mekele. The landscape is one of soft hills, with limited vegetation (although reforestation efforts may be reversing the trend). Most of the land is in cultivation, though it is rocky and not particularly fertile. The major crops are wheat and barley. SWC efforts are visible throughout the region, as many hills are terraced and planted in young eucalyptus or acacia trees.

Our study *kebeles* are Lemlem and Felege Mayat. Both have similar agro-ecologies, though Lemlem appears slightly more arid than Felege Mayat. Both *kebeles* are adjacent to an asphalt road. Felege Mayat has a market town of its own, but Lemlem residents walk to the market in the town of Qwiha (Enderta's administrative center), which takes three hours on average.

5.1.2 Ambasel – south Wollo zone – Amhara region

Ambasel is a *woreda* known throughout Ethiopia for the steepness of its mountains. It is located in the east of the region (known as the south Wollo zone), where the highlands of Amhara border the lowlands of Afar.

Despite the difficult terrain, agriculture is thriving in Ambasel. The steep slopes are carved into wide terraces to provide farmland. There are no signs of mechanization, but the land is relatively fertile and this region is less prone to droughts than Tigray. Of our four *woredas*, it has the largest diversity of cereal crops, with highly valued teff being a major product. Wheat, barley, and sorghum are all produced in large quantities, as are beans, lentils, and a variety of other legumes.

Despite the terracing, erosion remains an issue due to the extreme nature of Ambasel's terrain. Flooding is even more problematic. Temporary rivers and gullies fill up in the rainy season, often flood the surrounding fields, and cut through roads for months at a time.

Both of our study *kebeles* are rather difficult to reach. Joro Geta is accessible by car, about an hour away from an asphalt road. The center of the *kebele* is the town of Marye, which serves as a market town once a week for Joro Geta, as well as the four surrounding *kebeles*. One of these is Kolet, the neighboring *kebele* to the north. Kolet is the most remote *kebele* in our sample. Its center lies three hours away from Marye and cannot be reached by car.

5.1.3 Fentale – east Shewa zone – Oromia region

The Fentale *woreda* is the most arid of our study sites. It is located in the east Shewa zone, walking distance from the border with Afar. The main road leading east from Addis Ababa passes through the Fentale *woreda* and its main town, Metahara. It is a popular stop for truckers importing goods from the port town Djibouti into landlocked Ethiopia.

Much of the Fentale *woreda* is unfit for rainfed agriculture. The only crop to be seen is maize, with relatively poor yields, almost exclusively used for subsistence. Rudimentary irrigation structures (some of them financed as PSNP projects) can help boost yields, but they are relatively rare. The Awash river runs through the *woreda* and provides most of its water. It also supports an immense irrigated sugarcane field and an adjacent sugar refinery. Both are run by the government and require heavy infrastructure beyond the financial and technical means of the local population.

Livestock is by far the primary source of income. Each household owns several dozen to several hundred goats, and usually some cattle as well. The animals are almost never used for consumption; they are sold in the market in Metahara, and all resulting income is spent on grain.

Our case study *kebeles* are Lege Benti and Fate Ledi. Lege Benti lies directly on the main road. It has no marketplace of its own, and its inhabitants walk either to Metahara or to the Afar region to trade (a two-hour walk in either case). Fate Ledi lies by the Awash river, further away from the main axis. Due to its proximity to the river, Fate Ledi has slightly more crop production than Lege Benti (maize). It is also located by the sugar refinery grounds, where the government houses the 60,000 factory workers, many of whom are locals. It has a very small marketplace where farmers and workers trade in small amounts.

5.1.4 Shebedino – Sidama zone – SNNPR

Shebedino is the southernmost of our study *woredas*, located in the Sidama zone of the SNNPR. This area of Ethiopia benefits from nine months of rainy season and is more prone to floods than droughts. Accessibility for motorized vehicles can be an issue when water is present.

The climate in Shebedino supports a wide variety of crops. Agriculture is less dependent on cereal crops than in most of Ethiopia. The local staple is enset (*E. ventricosum*), a non-woody tree with a core that can be cooked and used for consumption (also called 'false banana' due to its similarity to the banana tree, though it bears no edible fruits). The most common cereal crop is maize. Coffee is grown throughout the *woreda* and is the primary cash crop, followed by chat. Fruit trees typical of tropical climates are also common.

Shebedino is the smallest *woreda* in our sample by area, the most densely populated, and also the wealthiest. The road network is denser, and motorized transport is more readily available. It is the *woreda* where we found most non-agricultural businesses: moto-taxi services, for instance, are thriving.

The two *kebeles* we study in Shebedino are Fura and Rameda, which are contiguous. Their economies are roughly similar, but Fura is closer to the *woreda* town of Shebedino and thus more integrated with local markets. Rameda has better developed livestock production.

Table 2: Overview of study sites

Region	Tigray		Amhara		Oromia		SNNPR	
Woreda	Enderta		Ambasel		Fentale		Shebedino	
Area (1,000 ha)	147		90.2		124		24.5	
Pop. (2007)	114,297		121,899		81,740		233,922	
Climate	Short rainy season.		Short rainy season.		Very short rainy season. Hot and dry.		Long rainy season (9 months).	
Agro-ecology	Mainly rainfed agriculture, with some irrigation from diverted rivers. Very drought-prone.		Mainly rainfed agriculture, with irrigation from diverted rivers. Somewhat drought-prone. Flooding a major issue in rainy season. Roads often impassable due to water.		Virtually no rainfed agriculture. Livestock the primary agricultural activity.		Lush tropical vegetation. Frequent flooding. Roads often impassable due to water.	
Kebele	Lemlem	Felege Mayat	Joro Geta	Kolet	Lege Benti	Fate Ledi	Fura	Rameda
Landscape	Dry and rocky land. Villages in 'canyons' where rivers flow.	Dry and rocky, but greener and hillier than Lemlem.	Mountainous. Steep slopes. Crossed by seasonal rivers.	Mountainous. Steep slopes.	Rift valley. Small hills and large plains.	Rift valley. Small hills and large plains.	Hilly. Red clay earth. Rainwater gullies.	Hilly. Red clay earth. Rainwater gullies.
Main activities	Crops	Crops	Crops	Crops	Livestock	Livestock	Crops	Crops
Main crops (in order of	Wheat Barley	Barley Wheat	Sorghum Teff	Sorghum Teff	Maize exclusively.	Maize exclusively.	Enset Maize	Enset Coffee

economic importance)	Teff Lentils Legumes Onions	Teff Finger millet Legumes	Wheat Barley Beans	Barley Beans Wheat		Sugarcane (government-owned only)	Coffee Beans Cabbage	Maize Beans Teff Chat
Main livestock (in order of economic importance)	Cattle Goats Sheep Camels Apiculture Poultry	Cattle Goats Sheep Camels Donkeys Poultry	Cattle Sheep Goats Poultry Donkeys	Cattle Goats Sheep Poultry Donkeys	Goats Cattle Camels Sheep	Cattle Goats Camels Sheep	Cattle Sheep Goats Poultry Donkeys	Cattle Goats Sheep Donkeys
Main PSNP projects	SWC Roads School	SWC Roads School	SWC (includes flood levees) Tree-planting Roads	Roads SWC	SWC Tree-planting Water harvesting Roads	Roads SWC Tree-planting Irrigation	Roads SWC Irrigation	Roads SWC Water harvesting

5.2 PSNP at our study sites

5.2.1 Scale and relative importance

The PSNP is the largest program of its kind in Africa by number of beneficiaries and one of the pillars of Ethiopia's development strategy. However, it is not implemented on the same scale in all regions. Table 3 records the number of participants in each *woreda* and the allocated budgets.

There is some variation in the spending per beneficiary, ranging from 409 ETB in Ambasel to 689 ETB in Shebedino. However, such a measure does not account for the type and scale of public works that were implemented. Tigray receives an average spend per beneficiary (570 ETB), but its overall budget is by far the largest. It also has the largest number of beneficiaries, both in levels (60,949 people) and as a proportion of total population (roughly 50% of population, though this number should be taken with caution as the most recent population estimate is from 2007). In contrast, Shebedino has the largest population, the lowest number of beneficiaries, and a small total budget. This suggests that the scale of what the PSNP is able to accomplish in terms of public works may be greater in Tigray than in Shebedino.

Table 3: Overview of PSNP in four case study *woredas*

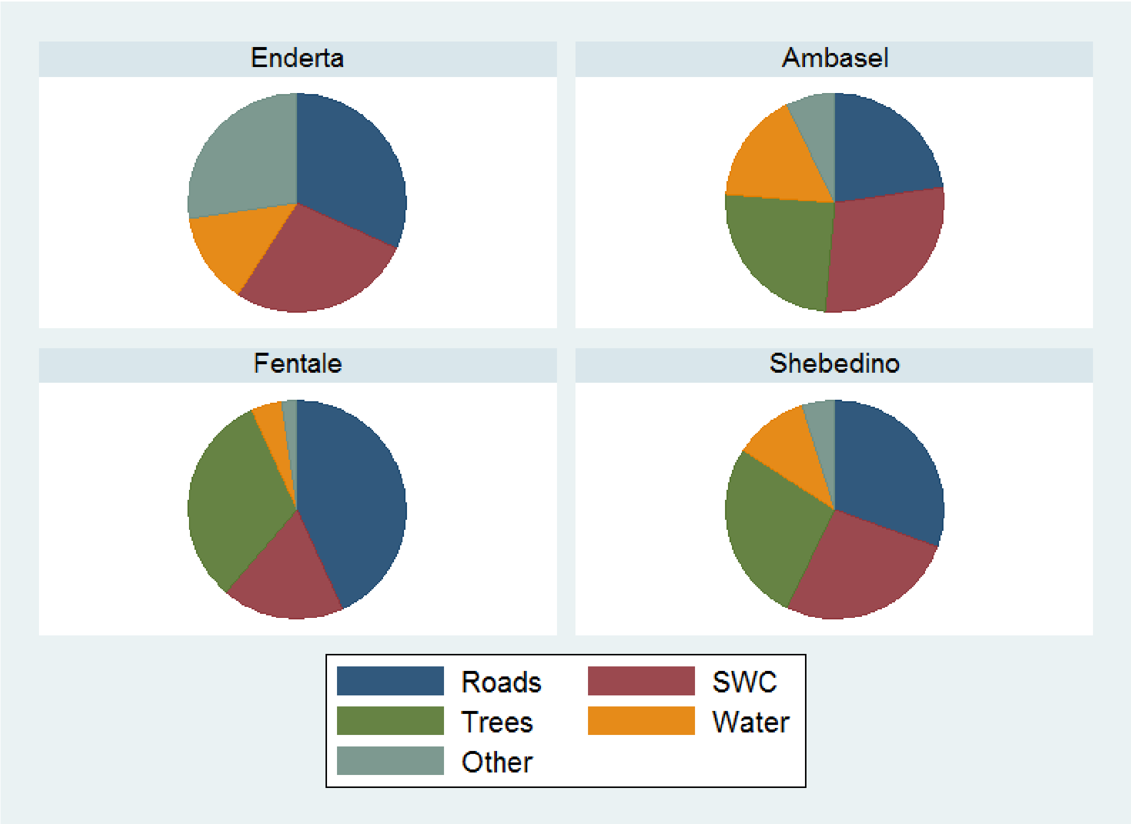
	Enderta	Ambasel	Fentale	Shebedino
Number of beneficiaries 2013, of whom:	60,949	53,572	12,209	8,562
Public works	*50,645*	*40,509*	*11,367*	*7,131*
Direct support	*10,304*	*13,063*	*842*	*1,433*
Budget for 6 months (ETB)	34,740,930	21,894,810	5,860,320	5,898,240
Spending per beneficiary (ETB)	570	409	480	689
Most recent population estimate (2007)	114,297	121,899	81,740	233,922

5.2.2 Types of projects

The PSNP funds a wide variety of projects, tailored to the needs of each community. The four *woredas* we study are strikingly different in the agro-climatic conditions they face, so the PSNP projects are likely to be implemented in different ways. However, we can broadly classify those projects into categories, which help paint the PSNP landscape in each *woreda* and draw comparisons.

Figure 6 shows pie charts of the PSNP projects which have taken place in our survey sites, by *woreda*, since the inception of the program, broadly classified into five categories (*kebele*-level pies are roughly similar within a given *woreda*). Those are 'road' projects, 'SWC' projects (with or without tree-planting), 'standalone tree-planting' projects, 'water harvesting' projects (which includes irrigation), and 'others' (most of which are construction projects, including schools and health centers). The pies reveal similarities shared by all *woredas*: roads are a relatively recurring type of project everywhere, as are SWC projects. Water harvesting projects are also frequent, though somewhat less so in Fentale. Standalone tree-planting projects were not implemented in Enderta (but tree-planting is usually a part of SWC terracing in Tigray). Enderta is also the only *woreda* where our sites show a large proportion of ‘other’ projects, which include building schools and clinics. The rest of this report is devoted to evaluating and simulating some of the effects of those projects.

Figure 6: Frequency of project types since 2005, by *woreda*



Source: *Kebele* community survey. Pie slices are proportional to the number of years the PSNP was involved in a given type of project in the two *kebeles* we study for each *woreda*.

5.3 Soil and water conservation projects

Due to the unique terrain and climate, erosion is a major issue in Ethiopia. In many areas, the situation is worsened by population pressures, which push out the land frontier through deforestation. Rainfall is highly variable: the heavy summer rains coupled with steep terrain lead to high soil erosion, which thwarts agricultural potential. In addition, frequent flooding results in losses in crops, livestock, infrastructure, and sometimes human lives. Roads are often rendered impassable for months at a time (Schmidt and Tadesse 2012; Shiferaw and Holden 2000; and own observations).

Efforts to reduce erosion are not new in Ethiopia. Traditional techniques relying on tilling such as contour furrows or raised bed cultivation have most likely been practiced for centuries (Gebreegziabher et al., 2009). In the past two decades, the government has stepped in to finance more technology-intensive erosion prevention techniques. Those primarily focus on physical structures designed to prevent water flow, such as soil bunds or stone terraces, as well as check dams in gullies. They are sometimes built on agricultural land and sometimes on the slopes above it. Stone terraces can be coupled with tree-planting (discussed below) in order to maximize soil retention and water percolation.

SWC is the most common type of PSNP project, reflecting both the priorities of local stakeholders and feasibility constraints. We collected data on 20 such projects during our fieldwork. We selected four of them as case studies, summarized in Table 4, to showcase the wide variety of ways in which SWC affects the village environment and economy.

5.3.1 Impacts of soil and water conservation projects

Crops. Reducing erosion is only the proximate goal of SWC projects, the ultimate goal being to improve agricultural output. When asked whether the project had influenced crop production, some farmers claimed that their yields had doubled after the terracing, for instance in Tsahilo (Felege Mayat). Unfortunately, there is no data to prove any causal relationship between the SWC project and yield increases in Tsahilo. However, at the national scale, a relationship between SWC projects and yields is also supported by rigorous econometric analysis performed in the context of this project by our collaborators (Dereje et al. 2013). Using all the EFSS panel data from all PSNP *kebeles*, they find that the presence of an SWC conservation project in a community raises yields of the major annual crops by 2.3 per cent on average.

Reducing erosion can also improve yields of permanent crops. In the Fura *kebele*, the Wamole project set up 15 hectares of terraces in abandoned coffee groves in 2006. When we visited the area, farmers explained that the trees had previously given very poor yields. Coffee beans would only grow in limited amounts and in the top branches only – nothing worth harvesting. The project terraced the area of the groves themselves; in between the pre-existing rows of trees, the soil was shaped into steps and reinforced with rocks. After the project, better soil and greater water availability have allowed the trees to start producing in harvestable quantities again.

Floods remain a problem throughout Ethiopia. Of our sites, the most flood-prone is Joro Geta. This year, as every year, water caused some damage to roads, destroyed a few levees, flooded some fields, and claimed a few donkeys. Yet some of the terraces built under the PSNP also held up against floods and some fields can now be harvested for the first time in years. The PSNP is helping to reduce the depth of flood problems in all four *woredas* in this study. Our *kebele* survey data shows that 14 out of the 20 SWC projects we collected data on have led to a reduction in complaints about the risk of flooding. Reducing the risk of flooding increases the average yield.

Livestock. According to our interviews with farmers, the terracing project in Tsahilo increased the availability of fodder for animals in two ways. First, it did so as an externality of the increased cereal yields. Few households grow crops directly for fodder, but the straw residue from cereals is usually dried, stored, and fed to animals throughout the slack season. Increased cereal yields thus also provide livestock with additional food. Second, it increased the overall vegetation density in the area. Most of the animals are usually left grazing in non-cultivated areas. Since SWC structures increase the general quality of soils and availability of water, they also increase the amount of vegetation growing in those areas. Check dams in gullies also retain soil and allow vegetation to start growing. This increases the availability of fodder in and around the terraced areas. While animals are not permitted to graze in the Tsahilo terraces themselves, this may change once trees have grown strong enough.

In addition to fodder availability, villagers in Tsahilo also mentioned that the SWC terraces had helped create new water sources downslope. This was seen as a benefit for livestock activities. Our *kebele* survey reports a stark decrease in problems relating to drinking water for animals. In Lege Benti, a water conservation project was also said to improve the grazing value of the area, with more grasses and longer-lasting water holes. Farmers reported that another major benefit of the project was the increased foliage in trees since the project started, which provides shade to their animals.

Table 4: Four case studies of soil and water conservation projects

***Kebele* (*woreda*)**	Felege Mayat (Enderta)	Joro Geta (Ambasel)	Lege Benti (Fentale)	Fura (Shebedino)
Project name	Tsahilo	Amito	Mugasa	Wamole
Year started	2011	2010	2012	2005
Type of structure	Stone terraces on hills above fields. Planted with rows of eucalyptus trees.	Stone terraces on hills above fields. Planted with rows of eucalyptus trees.	Stone terraces on hills above houses. Planted with acacias.	Stone terraces in coffee groves.
Goal	Protect the fields below from flooding. Prevent topsoil runoff.	Protect fields from flooding.	Protect houses from flooding.	Rehabilitate the groves themselves and also the fields downslope.
Area	358 ha	726 ha	5 ha	50 ha
Trees planted	60,000	129,000	0	10,500
Number of households affected (approx.)	450	250	40	420
Reported effects on soil and water	Erosion reduced.	Risk of flooding reduced. Erosion reduced.	Increased water availability.	-
Reported effects on yields	Doubled cereal yields in fields below.	-	-	Previously stunted coffee groves now produce normally.
Reported effects on livestock	New water holes downslope significantly reduce time needed to bring animals to water.	Increased availability of fodder and water.	Increased foliage in trees provides shade for herds.	-

Source: *Kebele* community survey.

Time use. Water availability created an unexpected externality in terms of time use. While fetching water for human consumption is a time-consuming task, an even bigger issue in much of Ethiopia is the availability of water for animals. Human requirements for drinking and cooking can be met with relatively small amounts of water, which can be fetched and carried home on a regular basis. Animals, on the other hand, require amounts that are too large to carry. Animals must be taken to a water source twice a day for drinking. The closer the water source, the lighter the constraint. In conversations, villagers emphasized that water availability frees up a sizeable amount of time previously spent taking livestock to water.

Between the increased availability of fodder and water, terracing projects have an indirect effect on animal grazing patterns. Animals remain closer to the village for longer periods of time, which reduces the amount of oversight they require. Another unexpected externality is that this increases the availability of cow dung around the fields and village, which is a non-negligible source of fuel.

5.4 Tree-planting

Tree-planting projects are almost invariably a component of SWC projects, as trees help fight soil runoff. In most of this report we will treat tree-planting as part of the SWC effort, but it can also exist as standalone projects and have additional economic benefits.

Erosion is partly due to Ethiopia’s terrain and climate, but it is aggravated by the lack of trees, which is a more recent phenomenon. Tree-planting projects are an attempt to reverse the historical deforestation trend, which has had dire consequences. Deforestation has been rapid and extensive in Ethiopia over the past century (McCann 1997). The country went from being roughly 40% covered by forests a century ago to less than 3% today (Bishaw 2001). The rift valley lost over 80% of its forest cover between 1972 and 2000 (Dessie and Kleman 2007). Recent reforestation efforts have been substantial, often coupled with SWC projects. While building terraces and check dams helps slow down the water, it is a symptomatic response to the erosion problem. Restoring the forest cover, on the other hand, treats the problem at its root. Trees participate structurally in the SWC goals, with a wide range of impacts as described in the section above: decreased erosion, improved yields, and reduced risk of flooding.

In addition, the trees can also generate new opportunities and sources of income which are welcome externalities of the conservation efforts. In some *woredas*, PSNP trees are used for construction (for example, eucalyptus, a very popular construction material in Ethiopia) and generate incomes. In others, acacias are planted and support lucrative beekeeping activities.

Table 5 gives an overview of PSNP tree-planting in the eight *kebeles* of our sample, reporting data for the three largest SWC projects handled by the PSNP.

Table 5: Overview of tree-planting projects

Woreda	*Kebele*	Number of trees planted	Trees planted in SWC terraces?	Terraced area on the SWC project (ha)	Trees/hectare
Enderta	Lemlem	193,000	Yes	489	394
	Felege Mayat	120,000	Yes	1,161	103
	Kolet	125,000	Yes	1,150	109
Ambasel	Joro Geta	354,000	Yes	1,346	263
	Fura	1,900	Yes	6.25	304
Shebedino	Rameda	18,000	Yes	380	47
	Lege Benti	2,030[a]	No	N/A	N/A
Fentale	Fate Ledi	0	N/A	N/A	N/A

Source: Community dataset. This compiles data from up to three SWC projects involving tree-planting in each *kebele*.

[a] None of these trees survived. These projects were successful in *kebeles* other than Lege Benti, but precise data on tree survival rates was not available.

5.5 Irrigation

Irrigation projects have direct benefits that are easier to observe and attribute than SWC projects. Irrigation projects at our study sites involve diverting a river to bring water to fields where agriculture is practiced. Small diesel pumps are sometimes used to pump water out of canals (but not groundwater) and further extend the reach of irrigation.

High investment in irrigation brings immediate high returns, unlike SWC which relies on a slow-acting rehabilitation process. Irrigation projects are also less frequent than SWC projects, perhaps because they often involve more technology-intensive work necessitating cement, whereas SWC projects mainly rely on labor. In addition, the benefits of irrigation are private rather than public, so that implementing a PSNP irrigation project requires more organization and planning to divide the benefits.

Irrigation is not always a completely new practice in the regions where we conducted the study. In some areas, farmers have diverted rivers to bring water to the fields in the past. However, the PSNP irrigation projects allow us to take this technology to a higher level. PSNP implementers or partners can bring in the tools and machinery necessary to build a larger construction, as well as the cement which makes it more durable. As such, even in areas where irrigation was previously used, the PSNP has the potential to dramatically increase the irrigated area and improve efficiency.

At one of our study sites, a remote community of the Lemlem *kebele* (Tigray), irrigation ushered in a transformative development dynamic. The village of May Aboaredom has a permanent source of water: a small river running at the bottom of a canyon. In the dry season it is reduced to a small stream, but it does not completely dry out. Traditionally, temporary mud canals diverted the water onto the left bank of the river. Each field gets flooded in turn, bringing much needed water to the land. The canals were shallow, about a foot deep, and usually had to be rebuilt every year. This allowed cultivation of higher-value crops but also allowed a lush vegetation to take hold, with species more reminiscent of a tropical climate than the arid Tigray. Mango trees, avocados, bamboo, and sugarcane can all be found along the irrigated stretches of land. The right bank cannot be irrigated due to topography and supports only low-yielding grains.

The PSNP built on that traditional knowledge and enhanced it with technology. A permanent cement dam now diverts the river higher upstream than the former mud structures did, and leads the water through 2,500 meters of permanent canals. Fields are still flooded in turn, over a much expanded area of 387.5 hectares. Only 30 per cent of that area was irrigated under the traditional system.

This irrigation project has a very direct impact on all households in the village, not just the PSNP recipients. The newly irrigated area was divided among all households, 403 of them. The irrigated plots support two to three vegetable harvests per year. Between the increase in irrigated area and the increase in yield, production soared in the village, as did marketed surplus.

5.6 From case studies to impact estimation

Case studies allow us to capture the context-specific variation which exists in the implementation of PSNP projects on the ground, and a window into the corresponding impact channels. However, they do not give us a precise estimate of the size of those impacts, demonstrate the causality, or ensure that similar impacts materialized in the average PSNP *kebeles*. That requires turning to econometric analysis.

6. Econometric evaluation of PSNP impacts

Using the generalized method of moments (GMM) methodological framework described in the methodology section, we can estimate the average impact of projects on specific outcomes in the areas where they get implemented. This econometric analysis fulfills two goals of our project. It allows us to obtain what are, as far as we know, the first numeric estimates of PSNP impacts beyond recipients themselves – in other words, the first estimates of the impacts represented by arrow (d) in Figure 3. The other use of these analyses is to provide us with parameters we can feed into LEWIE and CGE models so as to simulate the economy-wide impacts of PSNP. Indeed, while the safety net component is relatively straightforward to model (a cash transfer to recipient households simply loosens the budget constraint by the transfer amount), modeling the public works component requires estimating some impact parameters.

The GMM econometric framework we use can be applied to any project and, in principle, any measurable outcome of interest. To frame the analysis, we focus on the impact on agricultural yields. Informed by our case studies, we evaluate three channels through which the PSNP may have impacts on yields:

1) Impact of SWC projects on yields;
2) Impact of road construction projects on yields;
3) Impact of irrigation projects on yields.

There are a number of reasons we would suspect such projects to impact yields.[9] SWC may impact yields on a broader scale within the area by preventing runoff or floods and raising the water table. Roads may affect yields if they connect farmers to input markets (for instance by making fertilizer available) and output markets (which may raise crop values and incentivize farmers).[10] Studies have shown irrigation tends to increase yields in a crop cycle but may also allow farmers to grow additional crops out of season. Unfortunately we do not have data to verify most of these proximate channels; however, we are able to estimate whether the presence of a given type of PSNP project is associated with a significant increase in yields themselves.

6.1 Project statistics

Table 6 reports the number of projects of each type that were run in each region. SWC and road building are the dominant categories. We use econometrics to identify the impacts of such projects on agricultural yields.

Table 6: Total number of PSNP projects reported in the dataset – new construction and maintenance

	Region				
Year	Tigray	Amhara	Oromia	SNNPR	**Total**
Road	93	174	103	134	**504**
SWC, of which:	169	351	159	160	**839**
Soil conservation	*129*	*233*	*101*	*104*	***567***
Tree-planting	*40*	*118*	*58*	*56*	***272***
Well	42	50	34	25	**151**
Irrigation	33	44	11	7	**95**
Clinic	14	26	13	13	**66**
School	59	67	37	60	**223**
Total number of PSNP projects	**410**	**712**	**357**	**399**	**1,878**

6.2 Impacts of SWC and road construction on crop yields

Our study provides the first econometric estimates of the impacts of PSNP public works projects. We estimate those impacts not only to document and measure these overlooked effects of the PSNP, but also to provide parameters for our modeling and simulations.

One of the reasons broader impacts of the PSNP have never been estimated in the past is that they are notoriously difficult to measure. In what follows we present an original framework which allows us to estimate the impact of SWC projects and road projects on yields in the target area. The framework is based on IV and a GMM econometric specification (Dercon et al. 2009).

[9] While other types of public works may have an indirect impact on yields (for instance, schools may increase literacy and foster better use of fertilizer inputs; clinics may help raise yields by keeping the labor force healthy), those impacts are difficult to pick up in the time span of our dataset.
[10] Even though most PSNP roads are dirt roads, they may enable car travel or reduce travel time and as such may affect market connections.

6.2.1 Estimation of community assets in a GMM–IV fixed effects framework

The econometric evaluation strategy focuses on the impact of community assets built via the PSNP. Specifically, it explores the impact of roads and SWC structures constructed on crop yield growth in the sampled communities.

Following Dercon et al. (2009), we assess the effect of 'roads' and 'SWC structures' built by estimating yield growth specifications using GMM. Since we have a panel with four years of observations per household, this approach enables us to deal with a number of problems. First, appropriate instruments address the likely correlation between the endogenous outcome variables and time-varying household and community-specific characteristics and shocks. Second, differencing takes care of the possible influence of time-invariant household characteristics.

Crop productivity is measured by yield. Crop yield achieved by farm household i $\left(i=1,2,---,\mathrm{N}\right)$ from crop $j\left(\mathrm{j}=1,2,---,\mathrm{M}\right)$ in period t $\left(t=0,1,---,\mathrm{T}\right)$ can be estimated using the following functional relationship:

$$y_{it}^{j} = G(K_{it}^{j}, X_{i}^{j}, R_t, \epsilon_{it}^{j}) \qquad (1)$$

where *y* is crop yield (quintals/hectare), *K* captures 'roads' and 'SWC structures', *X* denotes a set of time-invariant household characteristics, such as location, that serve as control variables, *R* denotes time-varying circumstances exogenous to the household such as rainfall or prices, and *ε* represents the effect of unmeasured variables. As in Dercon et al. (2009), this paper applies an empirical growth model that allows for transitional dynamics. Specifically, the growth model for period *t* is stated as:

$$\ln y_t - \ln y_{t-1} = \delta + \alpha \ln y_{t-1} + \beta \ln K_{t-1} + \gamma(\ln R_t - \ln R_{t-l}) + \lambda X \qquad (2)$$

and for the previous period as:

$$\ln y_{t-1} - \ln y_{t-2} = \delta + \alpha \ln y_{t-2} + \beta \ln k_{t-2} + \gamma(\ln R_{t-1} - \ln R_{t-2}) + \lambda X \qquad (3)$$

However, we do not observe period *t*-1, which makes it necessary to average between period *t* and period *t*-2. The average of equation 1 and 2 is:

$$(\ln y_t - \ln y_{t-2})/2 = \delta + \alpha(\ln y_{t-1} + \ln y_{t-2})/2 + \beta(\ln k_{t-1} + \ln k_{t-2})/2 + \gamma(\ln R_t - \ln R_{t-2})/2 + \lambda X$$
(4)

In the above equation, the problem of estimating the lagged dependent variable y_{t-1} and other time-varying variables *kt*-1 will arise as we do not observe them. Like Dercon et al. (2009), we can assume that changes are slow so that $\ln y_{t-1} \approx \ln Y_{t-p}$ and the same for *k* so that the *p*-period average is approximated by the initial level at *t*-1. So equation 4 can be rewritten as:

$$(\ln y_t - \ln y_{t-2})/2 = \delta + \alpha \ln y_{t-2} + \beta \ln k_{t-2} + \gamma(\ln R_t - \ln R_{t-2})/2 + \lambda X \qquad (5)$$

Now we need to introduce a disturbance term, ε_{it}, into equation 5. ε_{it} has two components: a time-invariant component (μ_i) which captures all the characteristics of the village and the household not observed by us that do not change over time, and a time-varying component (u_{it}) which is a white-noise disturbance. Hence:

$$(\ln y_t - \ln y_{t-2})/2 = \delta + \alpha \ln y_{t-2} + \beta \ln k_{t-2} + \gamma(\ln R_t - \ln R_{t-2})/2 + \lambda X + \varepsilon_{t-2}$$

Fixed effects estimation of this regression equation eliminates the influence of unobserved time-invariant variables: the time-invariant household characteristics are differenced out. Dercon and others (2009) also emphasize the advantages of differencing from the mean.

6.2.2 Results

SWC programs potentially have indirect effects on yields. Yet those yield effects are notoriously difficult to evaluate with projects implemented at scale (rather than on test plots), because of the unclear nature of the affected area. Similarly, road construction projects may potentially increase yields by shifting relative prices, opening new markets, and generally shifting incentives, which are also mechanisms difficult to pick up in standard datasets. However, using a representative sample of the village populations, we can estimate whether yields have generally increased in areas where such projects were implemented, and by how much.

Table 7 shows that the construction of an SWC project or a road project in the community is associated with an increase in average yields in the community in the following round of the survey. Models A through E all present the same GMM–IV fixed effects specification, as detailed in the methodology section (equation 4), with an increasing number of control variables to check for robustness. All are fixed effects models, meaning that all time-invariant characteristics are controlled for, such as overall soil quality and slope or intrinsic household characteristics. Model A presents a basic result after including the basic variables of interest, road, and SWC, along with the lagged yield value and a dummy on whether the household was a PSNP beneficiary or not. The results from Model A suggest that the construction of an SWC structure leads to increased yield growth of 2.8 percentage points, statistically significant at the 5 per cent level. However, the specification reveals no statistically significant effect of roads on yield growth.

Because we use IV and a fixed effects framework, we can interpret the coefficients as revealing a causal relationship. In other words, these results are not simply reflecting unobserved characteristics which differ between areas with and without projects, nor reflecting the fact that project distribution is non-random. Rather, the significant coefficient on the SWC project suggests that the project did indeed enhance productivity.

We check the robustness of this result by running similar models with additional control variables that could be influencing yields and biasing results. Model B includes controls for the quantity of fertilizer and labor use. Models C, D, and E try to account for possible time-varying exogenous shocks which could confound our results. The rainfall shock is a dummy variable equaling 1 if the household had reported inadequate rainfall (shortage or excess) during harvest time. Crop disease or pest damage, death, input price shocks, and output price shocks are also dummy variables equaling 1 if the household has reported that they have been affected by such events. None of these additional control variables leads to any substantial change in the results. Model E, which includes all control variables, also shows a significant effect of SWC construction of 2.8 percentage points, and no significant effect of road construction on yield growth.

Table 7: Impacts on grain yields of SWC and road projects in the community

	Model A	**Model B**	**Model C**	**Model D**	**Model E**
Lag in yield real value	-0.120***	-0.133***	-0.135***	-0.149***	-0.151***
	(-3.39)	(-3.77)	(-3.80)	(-3.99)	(-4.05)
PSNP road construction in the community	**0.000**	**-0.003**	**-0.003**	**-0.004**	**-0.004**
	(-0.05)	**(-0.60)**	**(-0.56)**	**(-0.71)**	**(-0.77)**
PSNP SWC construction in the community	**0.028*** **	**0.026*** **	**0.025*** **	**0.027*** **	**0.028*** **
	(3.87)	**(3.59)**	**(3.48)**	**(3.78)**	**(3.67)**
Direct support beneficiary	-0.01	-0.013**	-0.013**	-0.013*	-0.014**
	(-1.60)	(-2.10)	(-2.12)	(-2.02)	(-2.17)
Public works beneficiary	-0.001	-0.003	-0.003	-0.003	-0.003
	(-0.14)	(-0.83)	(-0.84)	(-0.66)	(-0.77)
Log (fertilizer per ha)		0.001***	0.001***	0.001***	0.001***
		(4.51)	(4.61)	(4.51)	(4.60)
Hired labor		0.001	0.000	0.010	0.012
		(0.02)	(-0.00)	(0.21)	(0.26)
Rainfall shock			-0.055**	-0.060**	-0.060**
			(-2.27)	(-2.49)	(-2.52)
Crop disease or pest damage			0.002	0.000	0.002
			(0.12)	(0.02)	(0.13)
Death				-0.003	-0.001
				(-0.07)	(-0.02)
Input price shock					0.022
					(0.83)
Output price shock					-0.060
					(-1.55)
Constant	1.015***	1.144***	1.202***	1.331***	1.352***
	(3.17)	(3.57)	(3.67)	(3.85)	(3.90)
Hansen J test	0.3753	0.3746	0.3721	0.3061	0.3448
R-squared	0.187	0.207	0.21	0.224	0.227
N	6,674	6,603	6,603	6,447	6,447

Notes: t-values in parentheses; * significant at 10% level; ** significant at 5% level; *** significant at 1% level.

The SWC result suggests that a communal SWC asset positively changes yield growth through productivity gains. However, it does not give answers as to why exactly we observe such effects. Community-level SWC facilities, which mainly include various soil conservation activities such as building of bunds and terracing or tree-planting, help rehabilitate the soil and water resources within the community. Communities that have implemented SWC projects may have lower levels of flooding and erosion hazards. Our results suggest that such community-level improvements could further translate into higher productivity of households.

Similarly, although our results fail to identify any effect of PSNP road construction projects on yields, they do not tell us why that is the case. The lack of a discernible effect may reflect the fact that many PSNP road projects tend to be small-scale and do not significantly affect market access. We should not rule out the possibility that these effects exist for some of the larger PSNP road projects – unfortunately the data does not include enough information on project scale to test that hypothesis. It may also be the case that new roads make little difference to farmers' access to markets unless motorized transportation is available. The full impacts of PSNP road construction on yields might manifest in the longer run as market linkages strengthen. Our results call for further research on the linkages between roads, yields, and other outcomes suggested in the literature (Jacoby 2000).

Finally, applying a similar method to non-grain crops did not yield significant results. This may be due to the fact that we have fewer observations and more variability, diminishing the power of our econometric analysis.

6.3 Impact of irrigation on yields

Irrigation schemes are among the most common PSNP projects. We also use econometrics to estimate the impact of irrigation projects on agriculture, but have to apply a different methodology. In contrast to SWC and roads, the impacts of which are diffuse and indirect, irrigation projects affect clearly defined target areas (the newly irrigated fields). We can thus estimate their impact more directly by multiplying the irrigated area created by the PSNP by the irrigation yield premium. We use econometrics to compute each of these terms.

We first need to estimate the increase in irrigated area generated by the PSNP. Unfortunately data on the acreage of irrigation schemes was not collected, meaning that we need to resort to econometrics to estimate it. Even if we do not know which plots were irrigated specifically by PSNP projects, we still have information on whether a plot is irrigated for all plots of all households in our sample. We can use this information to econometrically estimate the average increase in total irrigated area after a PSNP irrigation project was implemented. We estimate the following regression at the *kebele* level:

$$\ln(irrigated\ area_t) = \beta_0 + \gamma I_{c,t} + \beta X_t + Y_t + \epsilon$$

where *Ic,t* is the cumulative number of irrigation projects in a *kebele* in year *t* (in other words the number of projects since the beginning of the PSNP), Xt is a set of control variables, Yt year dummies, and ε a set of geographic fixed effects. The controls include rainfall, temperature, and interaction terms between irrigation and rainfall. This gives us an approximation of the average increase in irrigated area in target areas for each project. Results appear in Table 8. It shows that each additional PSNP irrigation project increases the area under irrigation by about 1.5 hectares, which corresponds on average to a 150 per cent increase in irrigated area.

Table 8: Average impact of a PSNP project on irrigated area

Variables	(1) Irrigated area (hectares)	(2) Increase in irrigated area (%)
Cumulative number of PSNP irrigation projects in the *woreda*	1.500**	1.598***
	(0.697)	(0.590)
Rainfall	-0.356	-0.418*
	(0.258)	(0.250)
Temperature	0.053	-0.179
	(0.246)	(0.352)
Irrigation*rainfall interaction	-0.262**	-0.306***
	(0.101)	(0.107)
Irrigation*well-digging interaction	-0.338	-0.225
	(0.208)	(0.251)
Constant	0.732	1.932
	(4.217)	(6.316)
Observations	526	526
R-squared	0.330	0.361

Notes: Specifications account for *woreda* and year fixed effects as well as agro-ecological zone-specific trends. Percentage increase obtained by regressing on the log of irrigated area.

The next step in estimating the impact of PSNP irrigation projects on yields is to compute the yield premium that comes with irrigation. Table 9 shows the results of the estimation of the effect of irrigation on yields. The estimation strategy involves regressing the log of output quantity on an irrigation dummy. This is done with a dataset at the crop level, meaning each observation represents the production of a given crop by a given household. We use a fixed effects framework which removes the effect of any time-invariant characteristics of households and crops. This allows us to perform the analysis for groups of crops, rather than for each type of crop independently – which would reduce our sample size too much. The model we estimate is the following:

$$\ln\left(output_{c,t}\right) = \beta_0 + I_{c,t} + X_{c,t} + Z_{h,t} + \epsilon$$

where I_{ct} is a dummy for whether the crop was produced (at least partly) under irrigation, X_{ct} a vector of crop characteristics, Z_{ht} a vector of household characteristics, and epsilon an error term.

Results of this estimation suggest that vegetable crops respond strongly and significantly to irrigation, as seen in the first column of Table 9. On average, irrigation leads to vegetable yields increasing by 60 per cent. We performed the analysis for other types of crops as well, but none displayed a significant coefficient. In the table we illustrate this by reporting the result for all other crops. The reason why we cannot identify this impact is likely because the sample size of irrigated crops (other than vegetables) is so small. For most crops the share of irrigated production is below one per cent, such that even if we did identify a large and statistically significant increase in yields, this would remain insignificant in the face of total crop production. For vegetables on the other hand, 20 per cent of production comes from irrigated plots. Informed by these results, we focus on the impacts of irrigation on vegetable crops.

Our econometric results suggest that irrigated vegetable plots yield 60 per cent more than non-irrigated ones. This is an average number that applies to irrigation in general, not PSNP irrigation schemes in particular. Our data tells us whether a plot is irrigated or not, but does not tell us whether this was part of a PSNP scheme, so we cannot perform the same analysis on PSNP irrigation only. However, we feel comfortable making the assumption that irrigation leads to the same yield premium regardless of whether it was PSNP-funded or not.

Table 9: Impact of irrigation on yields: fixed effects model

Variables	Log (output) Vegetable crops	Log (output) Other crops
Irrigation (irrigated=1; otherwise=0)	0.603**	-0.0199
	(0.235)	(0.0852)
Area of land cultivated	1.338***	0.390***
	(0.429)	(0.0125)
Labor supply (number of household members aged between 16 and 60)	0.0666**	0.0107
	(0.0324)	(0.00972)
Chemical fertilizer (use of fertilizer=1; otherwise=0)	0.339**	0.165***
	(0.151)	(0.0286)
Number of tropical livestock units	0.00509	0.0178***
	(0.0224)	(0.00402)
PSNP beneficiary (beneficiary=1; otherwise=0)	-0.000327	0.0361*
	(0.0906)	(0.0212)
Other transfers (amount in ETB)	0.000283	-0.0549
	(0.000186)	(0.0376)
Interaction term: agro-ecological zone with time	0.0112**	-0.00847***
	(0.00447)	(0.00112)
Age of household head	0.00937*	-0.000736
	(0.00546)	(0.00151)
Sex of household head (male=1; female=0)	0.231	-0.101
	(0.351)	(0.0640)
Marital status of household head (married=1; otherwise=0)	-0.271*	0.0626
	(0.150)	(0.0453)
Major occupation (farming=1; non-farming=0)	0.0340	0.0776**
	(0.122)	(0.0391)
Constant	-72.38**	59.32***
	(28.65)	(7.367)
Observations	1,476	35,125
R-squared (within)	0.22	0.087
F stat	3.60	66.2
Prob. > F	0.00	0.0000

Note: the model also controls for household head education using 4 categorical variables (illiterate, grades 1–6, 7–8, 9–12, and college or more).

Putting the results of Table 8 and Table 9 together, we can tell that PSNP irrigation projects increase irrigated area by about 150%, and that vegetable yields are about 60% higher with irrigation. If we are willing to assume that the share of irrigated land devoted to vegetable cultivation is similar for land irrigated by PSNP projects and land irrigated under other schemes, then vegetables take up 13.6% of the newly irrigated land. Putting the three together, we can estimate the increase in vegetable yields due to the PSNP to be around 12%.[11] This is the figure we will use in our simulations to determine the economy-wide impacts of the PSNP.

6.4 Discussion

We find significant impacts of SWC on yields of 2.8 per cent yield growth. This impact is to be interpreted as an average yearly effect in zones which implemented an SWC project. We estimate that the PSNP leads to 12 per cent growth in irrigation yields, on a per-project basis. Yields depend on the size of the given project. Nevertheless, they give us a good estimate of what may be the impact on average.

We found that PSNP projects trigger yield growth. This in turn can lead to economic growth, a process which we can simulate in an economy-wide model. In the real PSNP on the ground, this is coupled with a transfer to eligible households, which we can also simulate. Putting this together, we can generate simulations of the PSNP at the local and national levels, thus evaluating the second order impacts of the yield growth we just estimated.

7. LEWIE modeling evaluation of PSNP impacts

Our econometric analysis gave us estimates of the yield impacts of PSNP projects. By simulating those impacts in a local economy-wide model, we can evaluate the full impact of the PSNP on the target local economy, including the spillover effects that ripple through the economy via market interactions between actors.

7.1 LEWIE methodology

The LEWIE methodology (Taylor and Filipski 2014) was designed to capture general equilibrium impacts at a local scale – precisely the kinds of impacts that are likely to be generated by the PSNP. LEWIE has its roots in input-output analysis (Leontief, 1986), agricultural household models (Singh, Squire, and Strauss 1986), and CGE modeling. There are two main advantages of these methods. First, they allow us to unravel the structural patterns underlying program impacts. They allow us to understand not just whether a project has an impact but also why and how the size and direction of that impact is determined. Second, such methods allow us to explore hypotheticals: alternative economic settings, alternative project designs, and so on.

7.1.1 LEWIE models

LEWIE models are structural models that rely on general equilibrium principles to represent whole economies, thus including both supply and demand of all commodity and factor markets in the economy. A LEWIE can be constructed for an economy of any scale: in this case at the *kebele* level. At its core, the model is focused on households,

[11] 150%*60%*13.6%=12.24%.

who are the producers and consumers in the economy. Equations in a LEWIE model describe the behavior of those households: how they combine inputs to generate outputs, how they spend their income on consumption, and how they trade with each other and the rest of the world.

The choice of using a LEWIE approach to evaluate the PSNP is directly motivated by the theory of change underlying the PSNP. The goal of the public works is to affect target economies as a whole, including through commodity and factor markets, and LEWIE is uniquely adapted to pick up such impacts. Only with an economy-wide approach can we unveil the full impacts of the PSNP. In addition, the data requirements for LEWIE are different from those of econometric analysis. The fact that the PSNP was not randomly rolled out poses serious challenges to econometric evaluation but is not a constraint for LEWIE. In addition, LEWIE benefits from the flexibility common to all simulation methods: it can be used to compare scenarios and explore hypotheticals that are of unique value to policymakers.

Armed with a LEWIE model, we can thus shed light on several sets of important questions. What are the contributions of community assets developed through the PSNP to both beneficiary and non-beneficiary households, as well as to the community as a whole, and what are the main channels of such contributions? What is the local spillover effect of the PSNP, what are the key factors (which are often not considered part of the PSNP) critical in enhancing the spillover effect of the PSNP, and how can such an effect be correctly measured? This interim report provides answers.

7.1.2 LEWIE equations

The LEWIE model nests household farm economies with household-specific consumption and production. Consumption is defined by Stone-Geary demand schedules. Production output is defined as the combination of value added and intermediate inputs. Value added is created from factors by a Cobb-Douglas production process, and intermediate inputs are added in fixed (Leontieff) proportions. There is no limit to the number of factors, commodities, or households that can be represented. Households are mapped into groups and villages according to their geographic location. There are five levels of tradability for commodities: subsistence commodities (consumed by the household who produced them); traded within groups of households (geographically isolated parts of villages); traded within villages; traded in regional markets; and fully integrated with outside markets. The same is true for factors, which can also be fixed in a given production activity. The model is set up in a way that allows us easily to alter those assumptions to perform simulations. The model is static in nature, though it can easily be modified to perform recursively dynamic simulations.

The formal model statement is provided in Appendix B, with tables providing the sets, parameters, variables, and equations in the basic model. Extensive information about the construction of LEWIE models is found in Taylor and Filipski (2014).

7.1.3 Calibrating LEWIE

As with standard CGE models, a convenient way to calibrate a LEWIE model is to use a SAM. A SAM is an accounting framework which represents all the value flows of an economy during a given period of time (in our case, and usually, one year). For our *kebeles*, the SAM portrays all the values of different crops, livestock, or other commodities and services that households produced, and all the values of inputs and factors they used in that process. It shows us how households made their income, and what they spent it on. It tells us where they trade and who they trade with. The SAM thus describes a full economic system in equilibrium.

The LEWIE model equations themselves can represent any economy until we set parameter values. They provide the ideal set of parameters to calibrate the LEWIE equations methodology, which imposes equations upon that system that correspond to assumptions about how the economy works. Then we can use this structure to gain insight into what may happen when the equilibrium of this system is disturbed, for instance by a PSNP project.

7.1.4 Simulating with LEWIE

This generic framework described here can be applied to model a wide array of situations, and it provides simple ways to simulate the PSNP interventions. Cash transfers can be simulated by altering an exogenous windfall income parameter. Yield improvements can be simulated by exogenously updating the parameters of production functions. In the results section, we describe in detail how we use the data to calibrate LEWIEs for our study *kebeles*, and how the results of our econometric analysis can be applied to the model to run simulations of the program.

7.2 Eight LEWIE models

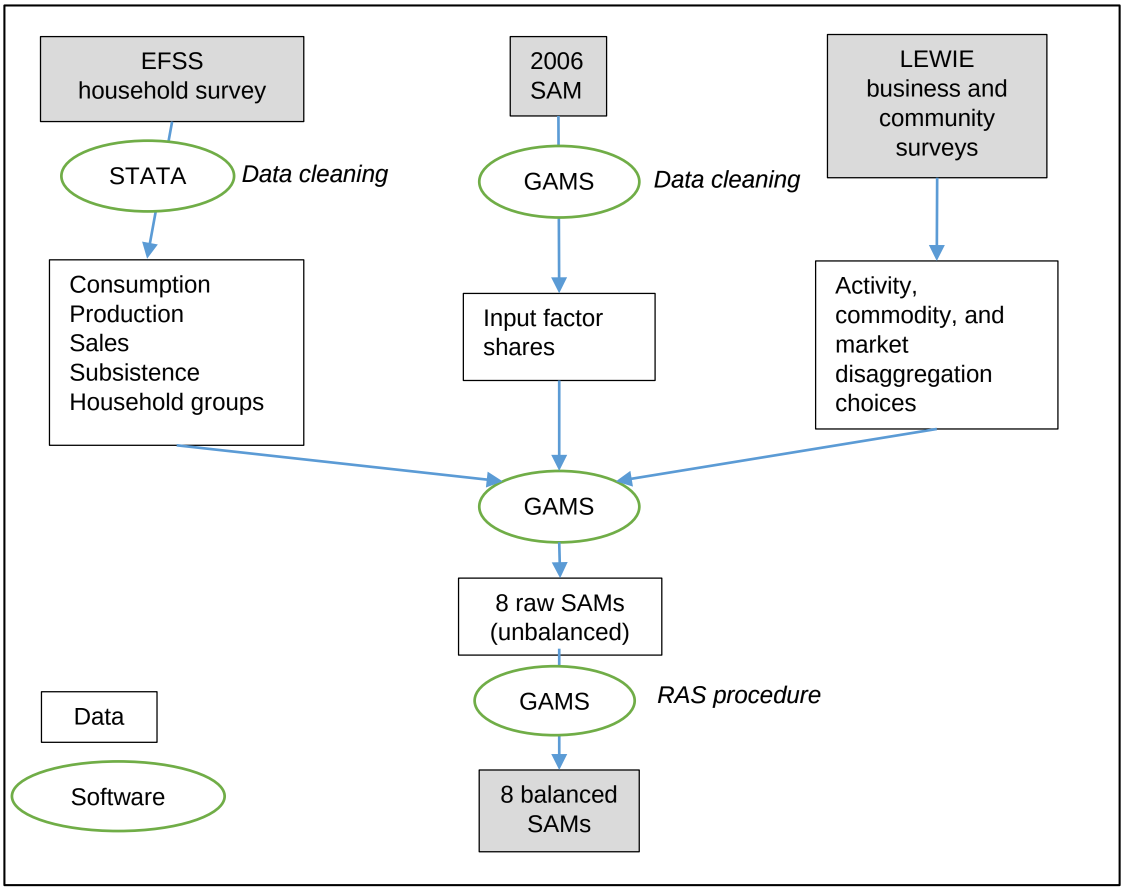
As described above, the LEWIE model requires calibration from a SAM representing the local economy being modeled. In this section we provide the details of how we constructed and parameterized eight LEWIE models, one for each of our case study *kebeles*.

7.2.1 SAM building

In order to build LEWIE models for our eight case study *kebeles*, we built a social SAM for each. Figure 7 provides an overview of the SAM construction process. The eight SAMs were all constructed following an identical process and based on the same three sources of data:

- The EFSS, a four-year longitudinal quantitative household and locality level survey administered every two years from 2006 to 2012. The surveys were carried out by the Ethiopian Central Statistical Agency in collaboration with IFPRI. They include detailed information on production, consumption, and income, all of which we require for SAM building;
- The 2005–2006 official SAM for Ethiopia, constructed by EDRI and available from them upon request (EDRI 2009); and
- Data we collected specifically for this project during our case studies and our preparation of the LEWIE for the PSNP. This data consists of qualitative information collected during interviews with local stakeholders, a community questionnaire at the *kebele* level (the LEWIE community survey), and a survey of local businesses (the LEWIE business survey). All are described in more detail in section 4.

Figure 7: Data and software usage for construction of the eight *kebele* SAMs



The SAMs were built according to the schematic process provided in Figure 7. Two software packages were used to manipulate the data: STATA and GAMS. We can divide our SAM construction process into two phases: 1) reading and manipulation of raw data into the appropriate aggregates, and 2) formatting of a raw SAM using the relevant aggregates and balancing. We now briefly describe each step.

The first phase consisted of manipulating the raw data, most of which was done in STATA. The data from our three sources were formatted into the aggregates which will appear in the raw SAMs. The EFSS was used to compute household total value of production and consumption by items. The selection of items to feature in the SAMs was determined according to the relative importance of commodities in the economy, and was made on the basis of our field visits and community and business surveys.

The production and consumption data were aggregated at the household-group level, with three groups distinguished in each *kebele*. The groups are distinguished according to their eligibility for the PSNP programs. The groups were: non-eligible for PSNP (group 1), eligible for PSNP with a public works requirement (group 2, public works), and eligible for PSNP without a public works requirement or with a partial requirement only (group 3, direct support).

Where there was a lack of information in the household data, factor use is extrapolated from the production totals, using shares borrowed from the official 2005–2006 SAM. The SAM was read using the GAMS software package, which was also used to compute intermediate input and factor shares in each productive activity featured in the SAM. Proportional weighting was used where item categories in our SAMs did not match one-to-one with categories in the official 2005–2006 SAM. The official SAM being disaggregated by agroecological zones, we matched each of our *woredas* (with both of its *kebeles*) to its agro-ecological zone according to a map provided in the official 2005–2006 SAM documentation (EDRI 2009). The matching is presented in Table 10.[12]

The EFSS also provides information on labor and wage work, which we used to allocate shares of labor factor incomes between the three household groups.

Table 10: Matching of SAM locations to agro-ecological zones in the official 2005–2006 SAM

Region	Tigray	Amhara	Oromia	SNNPR
Woreda	Enderta	Ambasel	Fentale	Shebedino
Kebeles	Lemlem and Felege Mayat	Joro Geta and Kolet	Fate Ledi and Lege Benti	Fura and Rameda
Agro-ecological zone	Drought-prone	Moisture-sufficient highlands – cereals-based	Pastoralist	Moisture-sufficient highlands – enset-based

The second phase of the SAM-building process consisted of formatting the data into SAM form, combining data from all the different sources into a single dataset in GAMS. The dataset contained all the values that would appear in the raw SAM: production, consumption, income, and factor uses for each household in each *kebele*, as well as the trade flows between each *kebele* and the rest of the world.

For each *kebele*, the aggregates were then placed into an Excel spreadsheet following the input-output double accounting framework which is characteristic of the SAM format. The eight raw SAMs, one for each *kebele*, were built simultaneously by the GAMS program.

At this point, each SAM contained a value in each of the cells that needed to be filled, but it was not “balanced.” As an accounting framework, a SAM must have equal inlays and outlays for each of its accounts features (which simply means that any value created in an economy or entering it must be accounted for). The final step was therefore to balance the SAMs. This was also done in GAMS, using a bi-proportionality routine known as the RAS procedure (Bacharach, 1970).

The resulting eight matrices are identical in structure and feature the same accounts. Table 11 presents the accounts common to all SAMs, which include all commodity and factor accounts. The SAMs only differ in terms of the household accounts, which are outlined in Table 12. The table also provides the abbreviations we will use when reporting results. The SAMs are available as an online appendix.

[12] The Ministry of Agriculture publishes a much finer classification into 18 different agro-ecological zones, though large amounts of data would be necessary to build a SAM distinguishing each of them.

Table 11: Account names in the *kebele* SAMs

Commodities and activities (ACT and COMM)			
Code	**Description**	**Code**	**Description**
TEFF	Teff	FORE	Forestry and wood
GRAI	Wheat, sorghum, and barley (major grains)	OUTS	Goods produced outside of the economy
MAIZ	Maize	PROC	Local food processing (milling, brewing)
PULS	Pulses	MANU	Local manufacturing (clay work, metal work)
OILS	Oilseeds	SERV	Local services
OSTA	Other staples (mainly enset and tubers)	EDUC	Education
VEGE	Vegetables	HEAL	Health services
FRUI	Fruits (tree fruits)	GIFT	Gifts from outside the villages
CASH	Cash crops (mainly coffee and chat)	INVE	Investments
OGRA	Other grains (millet)	PURF	Purchased factors of production
LLIV	Large livestock and livestock products (includes cattle, camels, donkeys, and horses)	TAXE	Taxes
SLIV	Small livestock and livestock products (includes poultry, sheep, and goats)		
Factors (FACT)		**Other accounts**	
Code	**Description**	**Code**	**Description**
LABL	Labor – unskilled	ROW	Rest of the world
LABH	Labor – high skilled		
LAND	Land		
HERD	Livestock herd or stock		
FCAP	Fixed capital		

Table 12: *Kebele* and household names and abbreviations

Abbreviation	JORO	KOLE	FELE	LEML	FATE	LEGE	FURA	RAME
***Kebele* name**	Joro Geta	Kolet	Felege Mayat	Lemlem	Fate Ledi	Lege Benti	Fura	Rameda
Households:								
Non-recipients	JOR1	KOL1	FEL1	LEM1	FAT1	LEG1	FUR1	RAM1
Public works	JOR2	KOL2	FEL2	LEM2	FAT2	LEG2	FUR2	RAM2
Direct support	JOR3	KOL3	FEL3	LEM3	N/A	N/A	FUR3	RAM3

*Note: household groups are three-letter codes followed by a digit. ‘1’ refers to ineligible households, ‘2’ to households eligible with public works only, and ‘3’ to households eligible with direct support. The Fate Ledi and Lege Benti samples did not include any direct support households.

7.2.2 Model parameters and assumptions

The equations of the LEWIE model are parameterized using not only the SAM for the modeled area, but also a set of assumptions defining the way markets function in the economy, often called ‘closure assumptions’. In particular, in the case of LEWIE, we define whether each good or factor in the economy is tradable or not; in other words, how do supply and demand for this good or factor interact to generate the price? At one extreme, a good or factor can be absolutely fixed in production – this is the case for capital and land in our model, which have little mobility in the short term. For these factors, supply is fixed and allocated to a given activity. If demand for them increases, their value increases, but households cannot reallocate them. At the other extreme, perfectly tradable goods (say, processed foods) are in perfectly elastic supply: their value will not increase no matter how much demand for them increases.

In the simulations we present below, we made the following closure assumptions: land and capital are fixed in production, low-skilled labor and livestock herds are tradable locally, and high-skilled labor is tradable nationally. Non-agricultural goods are all tradable nationally, as are cash crops, oilseeds, and fruit crops. Staple crops, vegetables, and meat are tradable locally. While it is not straightforward to determine whether a commodity or factor is traded locally or regionally, those assumptions are the most plausible in the context of remote economies.

7.3 Simulating the PSNP in eight *kebeles*

We simulate the PSNP by applying three shocks to the economy, which correspond to the average impacts we estimated econometrically. This means our simulations are representing the general equilibrium effects of average PSNP projects in each given *kebele*.[13] In addition to the impacts on crop and vegetable yields, we also simulate the transfer of funds to beneficiaries through cash transfers (public works or direct support beneficiaries). In the year 2006, this transfer totaled 18 per cent of beneficiary household incomes (total wages received from the PSNP divided by the sum of all income from all sources). This is the shock we simulate in both general equilibrium analyses. Each *kebele* engaged in the PSNP has implemented a different set of projects (see Table 2), and our simulations need to reflect that. Table 13 outlines the simulations we run in each of those *kebeles*.

[13] Naturally, it is not likely that PSNP projects had the same impacts in all *kebeles*. Applying the average estimated shock allows for comparability between the *kebeles*.

Table 13: Simulations of the PSNP in eight case study *kebeles*

Region	***Kebele***	**Projects**			**Simulations**			
		SWC projects	**Irrigation projects**	**Cash transfer**	**Crop yields**[a]	**Vegetable yields**[b]	**Beneficiary incomes**	
Tigray	Felege Mayat	yes		yes	**+2.8**		**+18%**	
	Lemlem	yes		yes	**+2.8**		**+18%**	
Amhara	Joro Geta	yes		yes	**+2.8**		**+18%**	
	Kolet	yes		yes	**+2.8**		**+18%**	
Oromia	Fate Ledi	yes	yes	yes	**+2.8**	**+12.5**	**+18%**	
	Lege Benti	yes		yes	**+2.8**		**+18%**	
SNNPR	Fura	yes	yes	yes	**+2.8**	**+12.5**	**+18%**	
	Rameda	yes		yes	**+2.8**		**+18%**	

[a] All the crops included (cereals, pulses, oilseeds, fruits, vegetables, cash crops). [b] Cumulative with general increase in crop yields.

7.4 Results

We ran the simulations described in Table 13 for each of our case study *kebeles*. Each simulation was performed in a separate LEWIE model, and the results were aggregated for comparison. That way we can illustrate the way the PSNP impacts economies differently depending on the economic structure of the local economy. The simulations are almost identical for all *kebeles*, except for Fate Ledi and Lege Benti where there was an irrigation project.

7.4.1 Production output

We first analyze the impacts of the PSNP on total output. We compute total output as the sum of all crop output but also output of other goods and services in the economy. It is a measure of the total economic stimulus generated by the PSNP. Table 14 reports the results of a simulation of the PSNP for each of the eight *kebeles*. The simulation has three components: cash transfer, SWC project, and irrigation project in the case of two *kebeles*. The first row of the table presents the full impact of simulating all three components together, which is the full PSNP simulation. In order to understand the contribution of the different components, we also simulate them separately and report results in the last three rows of the table.

The mean impact over all *kebeles*, reported in the last column, is a 6.4 per cent increase in total output. This average impact is far from negligible and highlights the fact that, beyond a simple safety net, the PSNP is indeed 'productive'. This number represents the net outcome of the cascade of economic processes triggered by the PSNP intervention and featured in the LEWIE models. This includes, but is not limited to, the increase in yields, the increase in demand for goods and services generated by the transfer, the ensuing shifts in prices reflecting new supply and demand, and the shifts in input prices and factor rents, as well as their allocation for the production of these goods and services. In other words, this is the 'local general equilibrium' estimate of the total productive impact of the PSNP.

Although the mean of this full impact is 6.4 per cent, there is a strikingly large variation in the amplitude of total production impacts between *kebeles*. They range from a 1.5% increase in total output for Fate Ledi to a 13.7% increase in Joro Geta. The other six *kebeles* have impacts fairly scattered in between those bounds. This means that, as far as local production is concerned, the impact of the PSNP can vary widely depending on the characteristics of the local economy – a point which we will keep clarifying throughout this section.

The bottom three rows of Table 14 model the three components of our PSNP simulation separately. The impact of the full PSNP simulation is not equivalent to a simple sum of the impacts of the three individual components, because of possible synergies or redundancies. Nevertheless, splitting out the different components is an informative exercise. In the mean, the impact of the cash transfer component is largest: the 18% increase in incomes for eligible households leads to a 5.4% growth in output. The impact of an SWC project in the community (estimated to be a 2.8% increase in crop yields) leads to a 1.0% increase in total overall output in the local economy.

The irrigation scheme, on the other hand, has a negligible impact on total local output in the community. This is because even a large 12 per cent increase in yields might have little weight in the aggregate if vegetables are too small a share of total production. This is not to say that irrigation has no impact – but simply that in the areas for which we had available data, the land area devoted to vegetable production in the base year was too small to influence aggregate numbers. There is little doubt that the size of this impact will increase as vegetable production gains momentum over the years. It is also possible that irrigation would influence the output of other crops than vegetables, but since our econometric estimations did not support that claim on average, the conservative approach is not to assume such impacts.

Table 14: Percentage increase in total output in LEWIE simulations of the PSNP

	Fate	Lege	Kole	Fura	Rame	Fele	Leml	Joro	**Mean**
Full PSNP	1.5%	1.8%	3.8%	4.8%	7.0%	9.1%	9.3%	13.7%	**6.4%**
Components:									
Cash transfer alone	1.2%	1.6%	2.1%	4.3%	6.3%	7.8%	8.1%	11.5%	5.4%
SWC alone	0.3%	0.3%	1.7%	0.5%	0.8%	1.2%	1.1%	1.9%	1.0%
Irrigation alone	0.0%	0.0%	0.0%	-0.1%	0.0%	0.0%	0.0%	0.0%	0.0%

We report the percentage increase output by item in Table 15. Looking at the mean, the largest increases in agricultural output are found in teff, maize, grains, and pulses, all of which have double-digit growth on average. There are also relatively large increases in vegetables, of 2.5 per cent on average. Large livestock output increases by 4.6 per cent on average, which is a clear indication of the existence of second order impacts, since livestock is not directly targeted by any of the simulations. Livestock output increases because of shifts in price incentives due, for instance, to greater demand for meat or greater availability of feed. Small livestock, on the other hand, decreases.

Output of non-agricultural goods and services is also driven by higher order impacts of the PSNP and can be seen at the bottom of the table. Local retail, in particular, increases by 14.5 per cent on average. Output of service provision increases by 2.4 per cent on average. Local processing and manufacturing, on the other hand, decrease on average. This should not be surprising: as households respond to shifts in incentives, they reallocate their productive resources towards activities which are more profitable, meaning that output of other activities is likely to decrease.

The average impacts on output production hide huge diversity between *kebeles*, which reflects their different economic base. Fura, Felege Mayat, and Joro Geta have cereal-based economies able to shift resources to teff when it becomes more profitable to do so. By contrast, the Fate Ledi and Lege Benti *kebeles* are located in a drought-prone region of Oromia which is not suitable for production of any grains except some maize, which explains the lack of impact in those cases. This also partly explains why those two *kebeles* show such small overall total impacts in Table 14: they have little to no crop production, meaning that neither the increase in yields nor the transfer-induced increase in local demand translates into a surge in local output.

Table 15: Percentage increase in output in PSNP simulations, by item

	Fele	Leml	Joro	Kole	Fate	Lege	Fura	Rame	**Mean**
Agriculture									
TEFF	26.5%	39.0%	26.3%	6.0%	0.0%	0.0%	6.1%	0.0%	**13.0%**
GRAI	18.4%	16.0%	23.8%	11.9%	0.0%	0.0%	25.0%	0.0%	**11.9%**
MAIZ	0.0%	17.9%	18.5%	6.6%	4.1%	6.7%	14.2%	16.4%	**10.6%**
PULS	21.8%	10.2%	20.6%	5.1%	0.0%	5.0%	0.0%	20.0%	**10.3%**
OILS	3.7%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	**0.5%**
OSTA	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	**0.0%**
VEGE	0.0%	3.2%	0.0%	2.5%	0.0%	0.0%	4.5%	9.6%	**2.5%**
FRUI	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	**0.0%**
OGRA	7.5%	0.0%	5.3%	4.7%	0.0%	0.0%	0.0%	0.0%	**2.2%**
CASH	0.0%	0.0%	2.9%	0.0%	0.0%	0.0%	0.0%	2.9%	**0.7%**
LLIV	0.5%	8.2%	1.8%	18.5%	0.0%	0.0%	1.5%	6.6%	**4.6%**
SLIV	0.0%	-5.5%	10.4%	-36.6%	0.0%	0.0%	1.8%	0.1%	**-3.7%**
Non-agriculture									
SERV	0.5%	0.0%	0.0%	0.2%	7.3%	9.6%	0.4%	0.8%	**2.4%**
RET	25.1%	24.1%	28.4%	10.3%	0.0%	0.0%	12.7%	15.7%	**14.5%**
PROC	-4.6%	-0.2%	-4.5%	-2.5%	0.0%	-0.1%	-24.3%	0.0%	**-4.5%**
MANU	-0.8%	-8.2%	-6.7%	-0.1%	0.0%	0.0%	-1.7%	-2.9%	**-2.6%**

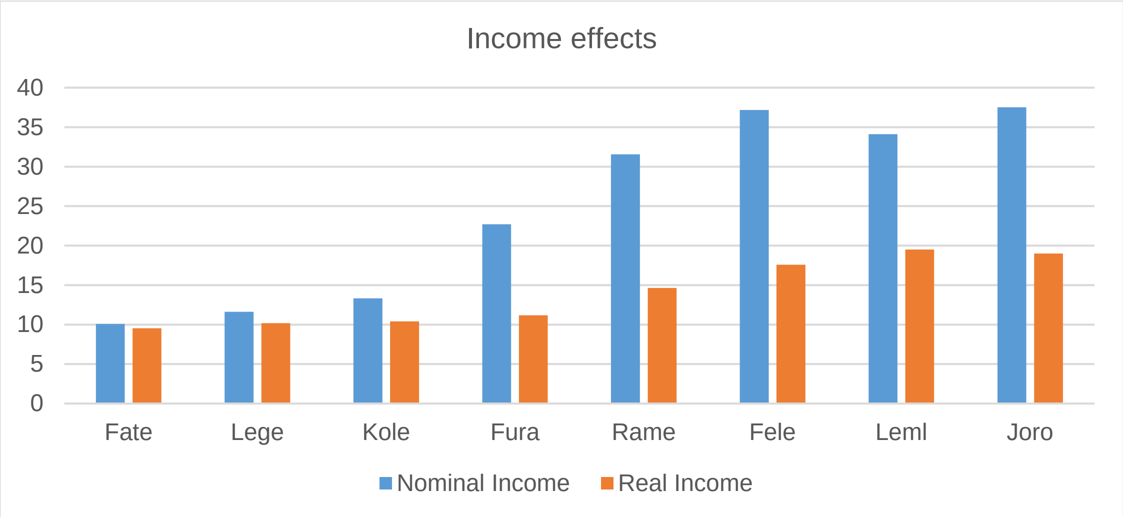
7.4.2 Household incomes

The PSNP generates increases in income directly for cash transfer beneficiaries, by 18 per cent on average according to our computations. This is modeled explicitly as part of our PSNP simulation. However, the PSNP is also possibly generating additional income because of the yield increases and second order impacts it triggers. Figure 8 shows the increase in household incomes for each of our eight studied *kebeles* in a simulation of the PSNP.

As with productive impacts, the impact of the PSNP on incomes varies widely from one *kebele* to the next. In nominal terms, incomes rise by as little as 10% in Fate Ledi and as much as 37% in Joro Geta and Felege Mayat. While this number might seem impressive, it may simply reflect the high level of cash turnover in the local economy and an increase in prices. The more informative measure is the real income, which is deflated to account for the changes in local prices reflective of supply and demand shifts.

In real terms, the increase in total household incomes in the eight *kebeles* ranges from 9.5% in Fate Ledi to 19% in Joro Geta. This large difference is again reflective of several differences between *kebeles*. One factor is the number of cash transfer beneficiaries relative to non-recipients, another is the crop intensity of the local economy, and a third is the extent to which local prices are affected by the program. In *kebeles* where prices increased most, there will be a big difference between the impact on nominal and real incomes (such as, for instance, in Felege Mayat), while in *kebeles* where prices increased very little there will be only a minor difference (such as in Lemlem). This again goes to show that, even with simulation designs, the structure of local economies shapes the local impacts of the PSNP.

Figure 8: Percentage increase in total nominal and real income in simulations of the PSNP

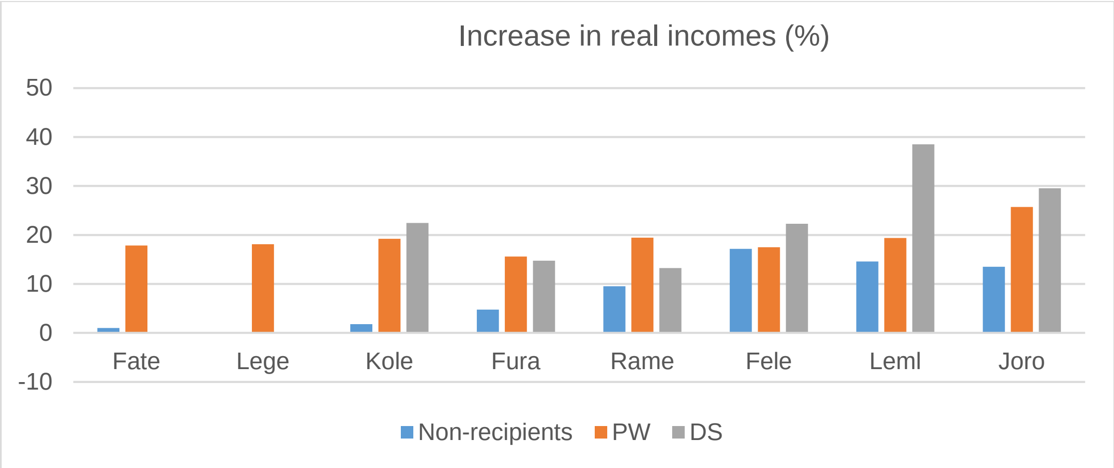


The LEWIE models we used distinguish between three types of households in each *kebele*, which allows us to perform a distributional analysis of income effects. Figure 9 reports the percentage increases in real incomes for each type of household: non-recipients, participants in the public works program, and beneficiaries of direct support.

Impacts on real incomes vary significantly and are even negative in some cases. The household group benefiting most in real income terms are direct support recipients in Lemlem. Their income increases by 38% in real terms, meaning that not only did they receive a cash transfer worth 18%, but they likely also benefit from the increase in yields and maybe spillover effects affecting their wages or the prices of items they purchase. All beneficiary households see increases in their real incomes. In most *kebeles* direct support recipients benefit more than public works recipients, but in Rameda they benefit less, and in Fate Ledi and Lege Benti they do not exist. This may reflect differences both in the way these households generate their incomes and in the way they spend those incomes. Direct support households tend to be poorer and may benefit more in relative terms when staple prices drop.

Looking at the non-recipient bars in Figure 9 reveals the effects of the PSNP on households that are not directly targeted by the cash transfer. In Joro Geta, the real income of these households increases by 13.4 per cent, reflecting increases in yields on their fields, cheaper food, and higher wages. At the other end of the spectrum, non-recipients in half of the *kebeles* are in fact *worse* off in the simulations (Kolet, Fate Ledi, Lege Benti, and Fura), with negative impacts on real incomes. This is not necessarily surprising: in every *kebele*, there may exist households who do not receive PSNP transfers and do not grow crops, but still need to purchase goods, services, inputs, and factors on the local markets. If prices or wages increase as a result of the PSNP, such households will be worse off. This result also highlights the importance of looking at the full impacts of the PSNP on the local economy. The project has the potential to generate positive or negative spillovers, depending on the structure of the local economy. Although the net impact is positive in all of our *kebeles*, the fact that some groups are potentially disadvantaged by some aspects of the PSNP is not to be overlooked.[14]

Figure 9: Percentage increase in real incomes in PSNP simulations, by households



Note: PW are beneficiaries who receive transfers and participate in public works, while DS receive the same amounts in the form of 'direct support' and are exempt from working.

[14] These simulations are limited to the short-term impacts of the PSNP. We are not modeling the impacts of school and clinic building, and we could not estimate longer-term impacts of public works, including roads. We can hope that in the longer run, the number of households impacted negatively by the PSNP will turn out to be very small.

7.4.3 Income and production multipliers

A cash transfer program always injects money into the local economies in the form of payments to beneficiaries. This constitutes income for the recipients, but as they spend this cash in the local economy, it becomes income for other households. A measure of the spillovers created in this case is the real income multiplier: the ratio of the real income generated by the transfer to the cash initially injected.

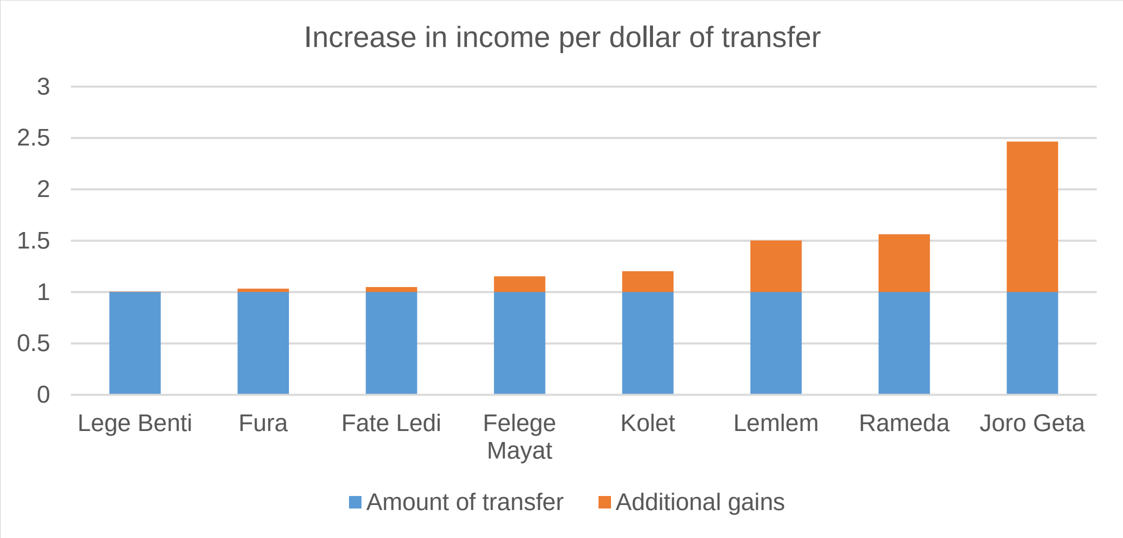
The case of the PSNP is slightly more complicated because, in addition to the cash transfer, there are public works being executed. If those works cost additional funds, that is *de facto* more investment into the economy. However, the PSNP has very scarce funding for machines and materials, and most projects are designed so that the payment to laborers represents the only cost. The cash transfer to public works households is compensation for working on the projects, and it is reasonable to say that the cost of the public works is in fact included in the cash transfer itself. To calculate a local income multiplier for the PSNP, we thus divide the total real income created by the project by the total number of transfers.

Figure 10 charts the size of the income multiplier in the PSNP simulation for each *kebele*. Multipliers vary widely, ranging from 1.0 in Lege Benti to 2.46 in Joro Geta, demonstrating again the diversity of impacts. A theoretical discussion on local multipliers is found in Filipski et al. (2015).

The multiplier can be interpreted as the real income created in the economy with each dollar of transfer. When this number is equal to one, the transfer creates exactly its own value in income, which is the case when transfers are small compared to the size of the economies they are distributed in. If a person living in New York is given USD 100, this will not influence prices in the city and de facto increases the total income of New York by USD 100 exactly in real terms. On the other hand, if half of the households in an Ethiopian village receive USD 100, the sudden influx of money can influence local demand enough to raise local prices, in which case the USD 100 is worth less in real terms.

In addition, increased prices decrease incomes of non-recipient households in real terms, which can quickly reduce the economy-wide multiplier. This is what happens in economies such as Lege Benti, where prices rise enough to dramatically reduce the overall multiplier. This does not mean that the program is not desirable, especially since the beneficiaries are the poorest segments of the population, but simply that there may exist complementary interventions which could increase the efficiency of the transfer.

Figure 10: Total income multiplier by *kebele*



At the other extreme, in economies like Joro Geta the transfer is creating a large multiplier. Not only does the cash transfer circulate through the economy, stimulating incomes beyond the original recipients, but the public works it funds also generate increased incomes. Our simulation suggests that every ETB of the PSNP injected into the Joro Geta economy generates a real income increase of 2.46 ETB – a rate of return that would not go unnoticed on Wall Street.

The same way we compute income multipliers, we can compute production multipliers: the value of output created by the PSNP for every dollar injected into the economy. Unlike income multipliers, the benchmark for production multipliers is 0 rather than 1, as any production generated by the transfer is a productive spillover.

Figure 11: Production multipliers in the PSNP simulations

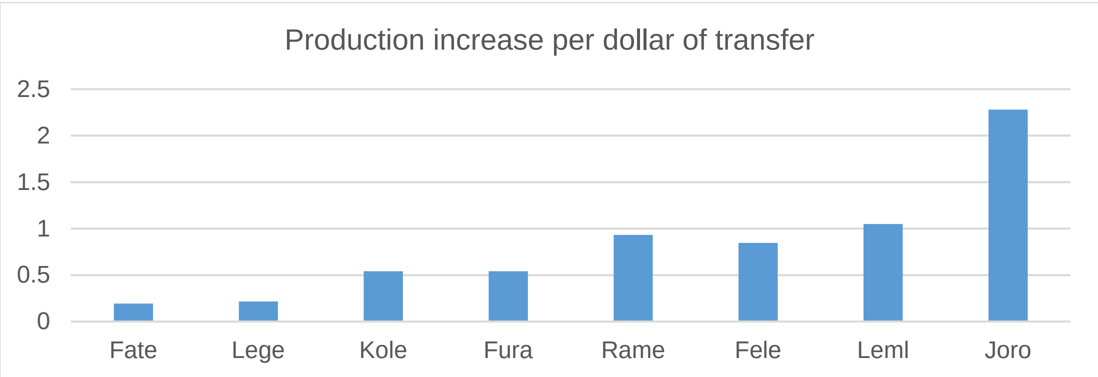


Figure 11 charts the production multipliers by *kebele*. They range from less than 0.1 in Lege Benti to over 2.28 in Joro Geta. The relative sizes of multipliers do not exactly follow the same patterns as the productive impacts themselves (percentage increase in output), because the multiplier is relative to the size of the transfer received by the *kebele*. Nevertheless, production multipliers are still the lowest in areas where productive responses were the most limited – the pastoral economies of Fate Ledi and Lege Benti.

The size of multipliers depends on a number of factors. Paramount among these is the ability of local producers to expand their supplies of goods and services as demand increases in the *kebele*. If the supply is unresponsive (or, in economic parlance, “inelastic”) in one or more sectors, the local income multiplier will be smaller. If on the other hand it is more elastic, the local income multiplier will be larger. However, we make the same assumptions about input supplies for all eight *kebeles*. (Assumptions which, incidentally, are not particularly heroic: land is fixed, there exists slack labor, and commercial inputs are imported.)[15] In this case, the differences in multipliers between the eight *kebeles* have more to do with the structures of the local economies themselves.

7.4.4 Explaining variations in impact between different kebeles

The magnitudes of local income multipliers created by the PSNP depend on a number of considerations, including how the beneficiary households spend their income, what goods and services are produced in the local economy, and the degree to which the local economy is integrated with outside (regional, national, and international) markets. A key indicator of all three of these considerations is the share of locally demanded goods and services that are supplied within the local economy. If this share is small, then the benefits of the program will leak out of the local economy quickly, resulting in a small local income multiplier. This does not mean that the program does not create benefits for the larger region or nation. The beneficiary households still benefit, as does the outside economy with which they interact.

If, on the other hand, much of the demand for goods and services is satisfied within the local economy, local income multipliers could potentially be quite large. The share of demand satisfied within the local economy does not have to be terribly large in order to produce a large income multiplier. For example, suppose all agents (households and businesses) in a village cluster spend half of their income within the cluster and half outside the cluster. A 1 ETB transfer would raise income in the beneficiary household by 1 ETB. Of this, 0.5 ETB would be spent on goods (say, a chicken) produced within the cluster, raising income in the chicken-producing household by 0.5 ETB.

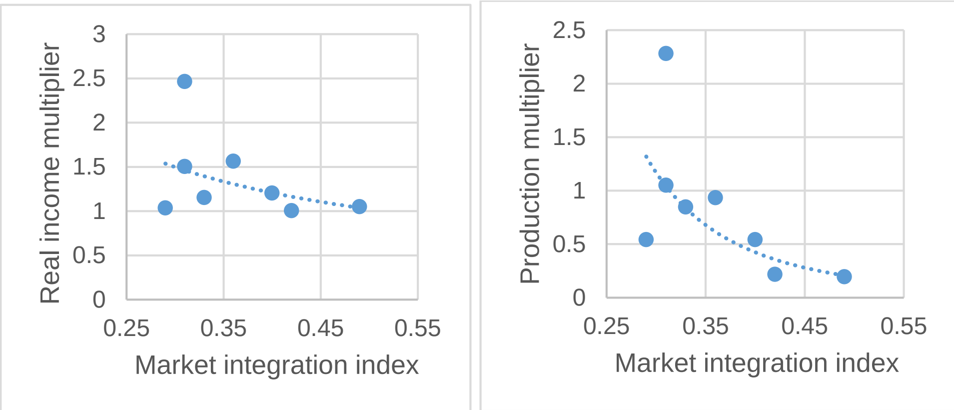
Thus, income in the cluster has risen by 1.5 ETB. The chicken-producing household, in turn, spends half of its income gain within the village (say, buying grain from a local farmer as chicken feed or food). This adds another 0.25 ETB of income to the village, half of which is spent within the village, and so on. The arithmetic limit of 1 + 0.5 + 0.25 + … is 2.0; in other words, if everyone spent half of their income in the cluster, the program’s multiplier would be 2.0, meaning that a 1 ETB transfer would raise local income by 2 ETB.

Figure 12 shows that the local income and production multipliers of PSNP transfers are lower in *kebeles* that are better integrated with outside markets. To measure market integration, we calculated the share of local demand satisfied by markets *outside* the *kebele*. This share ranges from one third or less in Lemlem, Felege Mayat, and Joro Geta to nearly one half in Fate Ledi. On one hand, these numbers reveal that households tend to spend most of their income close to home, and this favors the

[15] Previous studies explore how local supply constraints might limit income multipliers by changing assumptions in LEWIE models (Filipski et al. 2013; Filipski and Taylor 2012; Taylor and Filipski 2014; Thome et al. 2013).

creation of large multipliers from development programs. On the other hand, the downward slope of the relationship shows that local multipliers are lower in *kebeles* that appear to be more integrated with outside markets.

Figure 12: Relationship between market integration and size of income and production multipliers



8. CGE modeling evaluation of PSNP impacts

We used econometric techniques to estimate the average impact of PSNP projects on their communities. We then used local simulation models to show how those impacts ripple through the communities where the PSNP is implemented. Just as impacts spill over from beneficiaries to the communities around them, they may also spill out from targeted communities to the rest of the country. Because the PSNP is a large-scale program reaching hundreds of communities, the sum of all impacts at the community level may lead to an aggregate impact on Ethiopia that is not trivial. If the program is large enough to influence markets, for instance, via commodity or factor prices, then it can have an aggregate impact that is greater than the sum of impacts at the community level. Using a nationwide CGE model, we can explore the size of such impacts.

8.1 Methodology of CGE modeling

CGE models are the 'older brothers' of LEWIE models, both in the sense that they were developed several decades earlier and in the sense that they usually represent larger economies, typically entire countries. At the core, however, they belong to the same class of models. IFPRI has developed a standard model, widely reproduced in many countries, including Ethiopia. In this analysis, we tailored IFPRI's standard Ethiopia model to study the impacts of the PSNP nationwide.

8.1.1 IFPRI's standard modeling

A CGE model, like a LEWIE, is a set of equations describing the functioning of an economy. IFPRI's standard model, described in detail in Löfgren et al. (2002), is one of the most widely used CGE frameworks. The model is typically thought of as being composed of several blocks: production and factor markets, institutions, commodity markets, and macroeconomic balances.

Production activities in the standard CGE model follow nested constant elasticity of substitution and Leontief structures. The constant elasticity of substitution component determines value added by combining factors (such as land, labor, and capital), and the Leontief component adds intermediate inputs (typically commodities which are the output of other activities). Factor markets determine how wages are set. They can either be at full employment (flexible wage) or unemployed (fixed wage), and they can be fixed in production of a given activity or flexible for reallocation.

Institutions are typically agents of the economy: households and governments. Their economic behavior in the model is determined by a consumption function which follows a linear expenditure system, which is the result of maximizing Stone-Geary preferences under an income constraint. Institutions receive income by using the factors they own in production processes, or from transfers (including, for governments, taxes).

Commodity markets set the prices of commodities in the model. All national markets must clear (in the sense that supply equals demand) in the model, but they are integrated with international markets by means of imports and exports. The model uses an Armington specification to portray the trade-off between locally produced goods and imports, and a constant elasticity of transformation to portray the trade-off between selling on local and international markets.

Finally, the model offers various options with respect to macroeconomic balances: the government budget, the balance of trade, and the savings-investment balance. These options and their implications are presented in more detail in the model documentation (Löfgren et al. 2002).

8.1.2 Calibration and simulations in the standard IFPRI CGE model

As with LEWIE, the standard model is often calibrated using a SAM. Unlike LEWIE, however, which relies on household data, the national SAM is usually constructed from the national accounts. This was the case for the Ethiopia SAM we use as a base (EDRI, 2009).

The SAM represents a picture of the economy in balance, and the model is calibrated to reproduce this balance. Simulations are performed by disturbing this balance by altering a parameter, then observing the ways in which the model readjusts. We describe this process in more detail in the results section.

8.2 A CGE model geared towards the PSNP

We use the IFPRI standard model for Ethiopia (described in section 4) as a tool to evaluate the program nationwide. In order to do that, however, the model and data inputs need to be modified explicitly to feature the program. Most of that process is done by updating the national Ethiopia SAM to separate out regions where the PSNP is active.

8.2.1 Using a social accounting matrix with the PSNP

Rather than compiling a new SAM from scratch, in this project we start with a SAM that was originally compiled by a team of researchers at EDRI (EDRI 2009) and has since been used in many CGE applications (Dorosh and Thurlow 2009; Mitik and Engida 2013). The SAM represents the 2005–2006 economic year, which is ideal for our purposes as it coincides with the launch of the PSNP. However, the SAM needs to be modified before we can use it to simulate the PSNP.

The original structure of the SAM divides Ethiopia into four agro-ecological zones and an urban sector. In order to simulate the PSNP, it is also helpful for us to distinguish between regions with and without the PSNP. Regions with the PSNP represent a certain area in each of the agro-ecological zones, but it is not enough simply to split each of the zones into two subzones according to that share. Indeed, PSNP areas are very different from non-PSNP areas (namely, they are more food insecure, by design of the program). In order to capture that, we have to split each agro-ecological zone into a PSNP subzone and a non-PSNP subzone, each with its own economic structure: specific activity mix, factor endowments, and household population.

The first step was to determine the output of activities in each of our subzones. Only agricultural activities are separated into agro-ecological zones in the original SAM. For each of them, we first determined which fraction of output is produced within the PSNP *woredas*. We used data from 2001 on agricultural land use and output from the Ethiopian Agricultural Sample Enumeration carried out by the Ethiopian Central Statistical Agency. We mapped all observations in the sample to the PSNP or non-PSNP zone, depending on whether or not the observation came from a *woreda* that would later be part of the program. We used this to compute the share of output coming from each subzone (reported in Appendix A). We then used those shares to split all agricultural activities into PSNP and non-PSNP. At the end of this process, the PSNP SAM had 192 sectors of production, 134 of which were divided by PSNP and non-PSNP status, and the others nationwide.

The division of total output in each activity into PSNP and non-PSNP sectors also leads us to divide input use and factor use in the same way. This, in particular, allows us to divide land allocation between PSNP and non-PSNP areas. The last step is to use those shares of land in the PSNP and non-PSNP areas to split household accounts into those living in PSNP areas and those living in non-PSNP areas. Households in the SAM are represented by their incomes and expenditure, and it makes sense to assume that income from land generated in an area accrues to households in that area. These last two steps are crucial to ensure that income from agricultural production in PSNP areas generates income for households in those areas, rather than being spread across the agro-ecological zone (which would overestimate regional spillovers).

The procedure of distinguishing the PSNP and non-PSNP areas in the national SAM was all performed within the GAMS software package. The final step was to perform an RAS procedure (or ‘bi-proportional fitting’) to balance the accounts. The original SAM had 238 accounts, while the final one has 318. A simplified list of these accounts is provided in Appendix C.

8.2.2 Model parameters and assumptions

CGE models are flexible tools that allow us to model very different types of economies by changing certain parameters of the model. In particular, the choices made regarding the way markets clear in the economy, often called the ‘closure assumptions’, are crucial in determining the way the model will behave.

In all the simulations presented in this report, we assume savings-driven investments, fixed tax rates, flexible exchange rates, and a flexible consumer price index. These are usually referred to as the ‘macro closures’. Table 16 provides a summary of these assumptions. These assumptions are all fairly standard for most single-country CGE models. More information on the implications of these assumptions is available in IFPRI's standard CGE manual (Löfgren et al. 2002).

The next set of closures concern markets for factors. The model distinguishes between 30 different factors, which are different types of land, labor, capital, and livestock. There are five types of labor: agricultural labor and unskilled labor are both considered fully mobile and not fully employed, while administrative, professional, and skilled labor are mobile and fully employed. There are 16 types of land (belonging to poor or non-poor households in PSNP or non-PSNP areas of each of four agro-ecological zones), all considered fully utilized but mobile between sectors. The same is true for the eight types of livestock (belonging to poor or non-poor households in each agro-ecological zone). Capital is fully employed and fixed in production.

Table 16: Closure assumptions in the PSNP CGE model

	Closure assumptions
Macro closures	
Savings-investment balance	Savings-driven investment (savings rate fixed, investment flexible)
Government budget	Tax rates fixed, government savings flexible
Exchange rates	Exchange rate flexible, foreign savings fixed
Consumer price index	Consumer price index flexible, domestic producer price index fixed
Factor market closures	
Labor:	
Agricultural, unskilled (2 sectors)	Mobile between sectors, with unemployed surplus
Skilled, administrative, professional (3 sectors)	Mobile between sectors, without unemployed surplus
Land (16 sectors)	Mobile between sectors, fully employed
Livestock (8 sectors)	Mobile between sectors, fully employed
Capital	Fixed by sector, fully employed

8.3 Simulating the PSNP nationwide

As for the LEWIE models, we need to convert the estimation results we obtained from econometric analysis into shocks we can simulate in a CGE model. We implement the same simulations as previously: a 2.8% increase in crop yields, a 12% increase in vegetable yields, and an 18% increase in the incomes of beneficiaries. The size of these shocks was determined by our econometric estimations, but they need to be prorated to reflect the way accounts in the model are defined. In addition, the confidence bounds on those estimations allow us to provide a range of plausible impacts. In what follows, we perform three simulations: one using the average estimated impact, a more pessimistic one using lower bounds, and a more optimistic one using higher bounds. Table 17 provides a summary of the three simulations we perform to simulate the PSNP in the national CGE model.

Simulations of crop yields are straightforward to implement, because we can directly use the point estimate from our regression analysis. Table 17 shows that a *woreda* with an

SWC project sees an increase in grain yields of 2.8% (with confidence bounds at 2.1% and 3.5%). Because the model distinguishes PSNP areas from non-PSNP areas, we can simulate this directly by applying a 2.8% exogenous increase to the total factor productivity parameter for all crops grown in those areas.[16]

We established that irrigation increased yields by about 60% on average, with a standard error range of 36%–84%. Assuming again that irrigation projects in PSNP areas increased irrigated land by 150% on average, and that 13.6% of that land is used for vegetable production, this leads to an impact of 12% with bounds at 7% and 17%.

Finally, we estimated that the cash transfer represents 18% of the income of recipients, with bounds at 11% and 27%. In order to simulate this in the national model, we have to prorate this number to the proportion of recipients among poor households. Since recipients constitute on average 63% of the poor in PSNP areas, the PSNP transfer represents an average 11% increase in income for poor households living in PSNP areas, the group explicitly featured in the model.[17] The lower and upper bounds are 6.9% and 17% respectively.

Table 17: PSNP impacts to simulate in the national-level CGE

	Average impact	Lower bound	Upper bound
Impact of an SWC project on overall grain yields	2.8%	2.1%	3.5%
Impact of irrigation on vegetable yields	12%	7%	17%
Share of PSNP transfer in the income of beneficiaries	11%	6.9%	17%

8.4 Results

We ran the simulations described in Table 17 using the PSNP-modified national CGE for Ethiopia. The results should be interpreted as the aggregate effects of one year of the PSNP on the national economy, including areas not targeted by the PSNP but indirectly affected through market interactions.

8.4.1 Production output

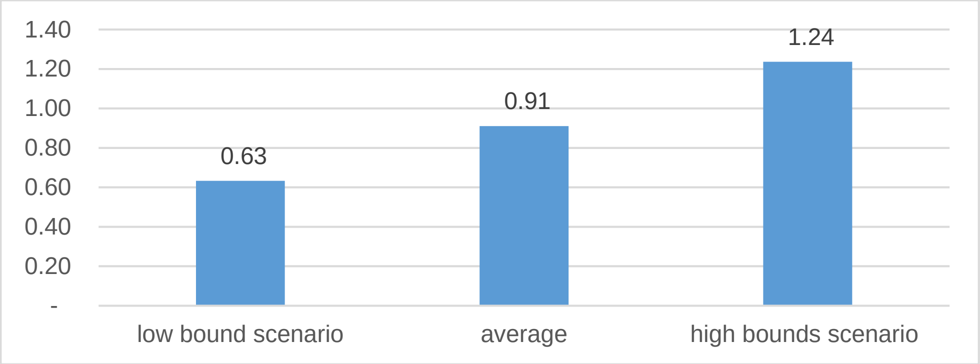
We report the percentage increase in total output nationwide in PSNP simulations under the three scenarios in Figure 13. Total output increases by 0.91% in the average scenario, or by 0.63% and 1.24% respectively in the lower and higher bound simulations. Considering that the PSNP targets the most disadvantaged areas of the country, a nationwide impact on production nearing a percentage point is far from trivial. This result

[16] The exact list of crops we apply this shock to features teff, wheat, maize, barley, sorghum, pulses, oilseeds, vegetables, fruits, enset, chat, and coffee. We deliberately exclude large governmental plantation crops such as sugarcane, which would not be affected by PSNP projects.

[17] Recipients constitute 21% of the whole population of PSNP areas (based on program records at our study sites), but we draw only from the poor, who constitute 33% (poverty rate in 2006); 0.21/0.33=0.63. So overall the shock is equivalent to a 0.63*0.18=11% shock to the expenditure account of poor households in PSNP areas.

bolsters the notion that the PSNP cannot be viewed as a simple safety net program, and cannot be evaluated properly without addressing the productive component.

Figure 13: Percentage increase in total output nationwide in PSNP simulations

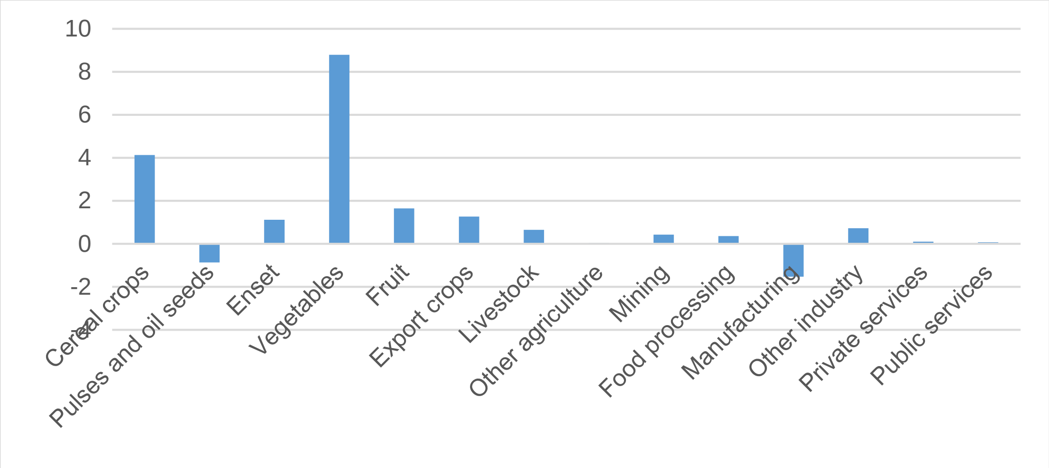


We disaggregate the average result by sector so as to identify where the program had most impacts. While the model features over 60 separate activities, we grouped them into higher-level categories to facilitate analysis. Results are charted out in Figure 14. The vegetables sector saw the largest growth, 8.7 per cent, which is not surprising given that it experienced the largest yield shock. The cereal crops sector is second, with a 4% increase, followed by fruits, export crops, and enset just above 1%.

Consistent with what we saw in the LEWIE simulations, it is important to observe that not all crops are positively impacted. The output of pulses and oilseeds drops in the simulation, as farmers allocate their productive resources to other crops. This also illustrates the point that the output results are not simply reflective of the increases in yields we simulate, but also of the supply and demand shifts triggered by the shocks. The yields of pulses, oilseeds, and grains all increase by the same amount in our simulations, but it turns out that the market mechanisms favor grain production.

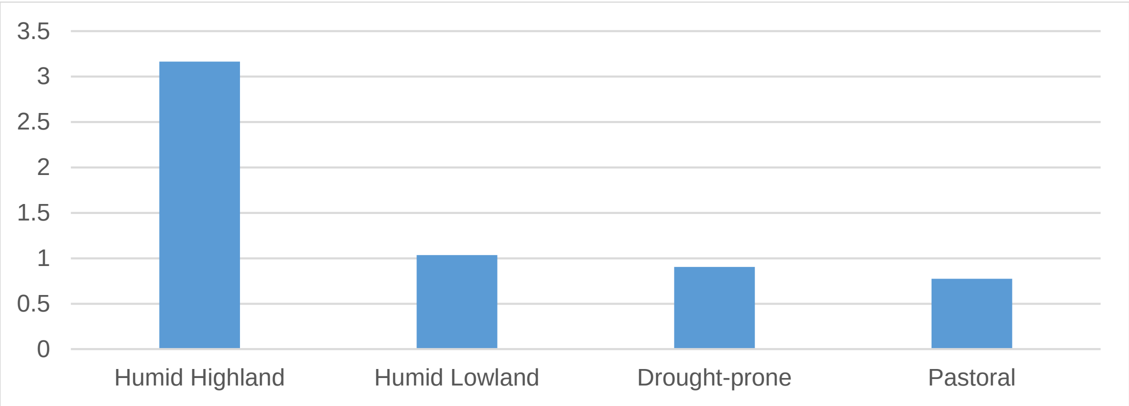
Another important point to make is that non-agricultural sectors are also impacted – although to a limited extent. Food processing rises somewhat, as it benefits from the increase in availability of its raw materials. Manufacturing, on the other hand, decreases somewhat, as resources shift to other activities. Such impacts are small but non-negligible, and again illustrate how the impact of the PSNP ripples through the economy of the whole country.

Figure 14: Percentage increase in output by sector, PSNP average scenario



Finally, we also chart out productive impacts by agro-ecological zone, in Figure 15. It appears immediately that the humid highlands are where the PSNP has the highest impact. This partly reflects the fact that these areas are more suitable for crop and vegetable production, and thus can benefit most from the PSNP yield improvements. However, this region is also the one with the highest PSNP coverage.

Figure 15: Percentage increase in agricultural output by agro-ecological zone, PSNP average scenario



8.4.2 Incomes

Using a CGE model allows us to simulate shifts in household incomes for each group distinguished in the model. Income is computed as the value of all factors, in real terms. We report some of these results in Table 18.

The table reveals that the PSNP is on average increasing household real incomes by 3.9% (with bounds at 2.6% and 5.6%, respectively). This corresponds to about 5.17 billion ETB of additional real income. Although the model distinguishes 20 different household types, we report results grouped into categories that facilitate comparisons.

Focusing first on the regions where the PSNP is active, we distinguish the target households who receive the transfer (poor households in PSNP regions) from their neighbors who are non-poor. Real incomes of target households increase by 14.1%, while their neighbors' real income increases by only 2.9%. This difference is not surprising, since the target households are the ones actually receiving the cash transfer. Yet the 2.9% increase in real income for households that are not direct beneficiaries is testimony to the existence of broader impacts beyond recipient households and the need to evaluate them.

We widen the net and look at impacts outside of PSNP areas. Overall, poor rural households gain 8.4% in real income, while non-poor rural households only gain 2.6%. The distribution of impacts on real income favors the rural populations and the poor, consistent with the program targeting scheme. Importantly, urban households gain almost as much as non-poor rural households (2.1%), which underscores the size of the potential spillovers. Some urban households may be participating in activities which are stimulated by the general increase in demand generated by the PSNP – for instance food processing. Furthermore, increased production may drive down the prices of some consumption goods, which benefits urban households in real terms even if it does not increase their nominal incomes.

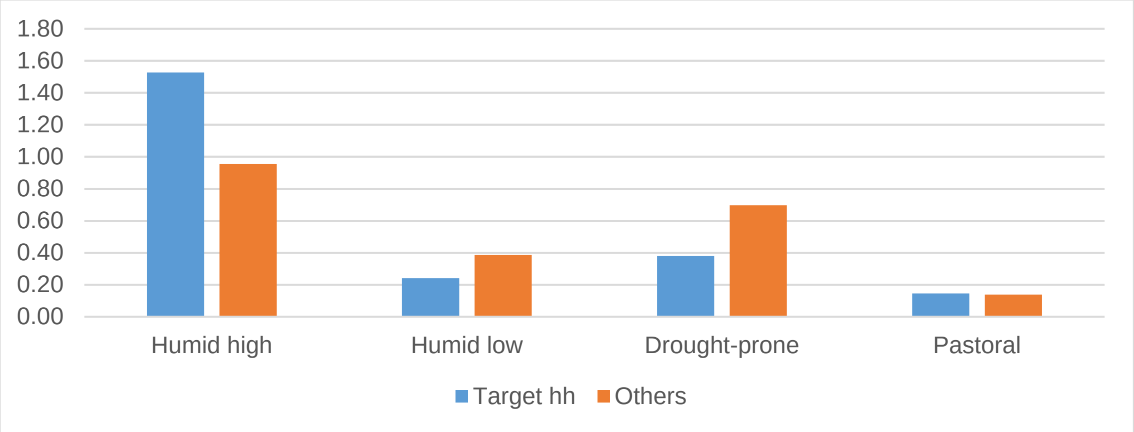
Table 18: Impacts of the PSNP on household incomes, average scenario

	Percentage change			Level change (in billion ETB)		
	Average	Low bound	High bound	Average	Low bound	High bound
All households	**3.9%**	2.6%	5.6%	**5.17**	3.47	7.51
PSNP areas, of which:	**6.4%**	4.2%	9.4%	**3.23**	2.13	4.79
Target households	***14.1%***	*9.1%*	*21.2%*	***1.53***	*0.99*	*2.31*
Non-poor in PSNP areas	***2.9%***	*2.0%*	*4.1%*	***0.69***	*0.47*	*0.96*
Rural areas, of which	**4.4%**	3.0%	6.5%	**4.47**	2.98	6.54
Rural poor	***8.4%***	*5.5%*	*12.6%*	***2.73***	*1.78*	*4.08*
Rural non-poor	***2.6%***	*1.8%*	*3.6%*	***1.74***	*1.20*	*2.45*
Urban	**2.1%**	1.4%	2.9%	**0.70**	0.49	0.97

To see which groups of households benefited most in monetary (rather than percentage) terms, we disaggregate the impacts between the target households (the poor in PSNP areas) from all others, for each region. Results are charted out in Figure 16. Households in the humid highlands gain most – reflecting the patterns of increase in agricultural output. Pastoral regions, which are also less populous, gain least.

Non-target households do not receive any transfers, yet the figure shows that they actually gain more than target households in two of the regions. This again illustrates the importance of taking broader impacts into account when evaluating the program. A small increase in yields spread over many households may aggregate to a large increase in total income. Most likely, the households who stand to gain from that increase in yields are not the asset-poor PSNP recipients, but rather those who own agricultural land. Our simulations suggest that in drought-prone regions, the PSNP generated almost double the income for non-target households than for target households.

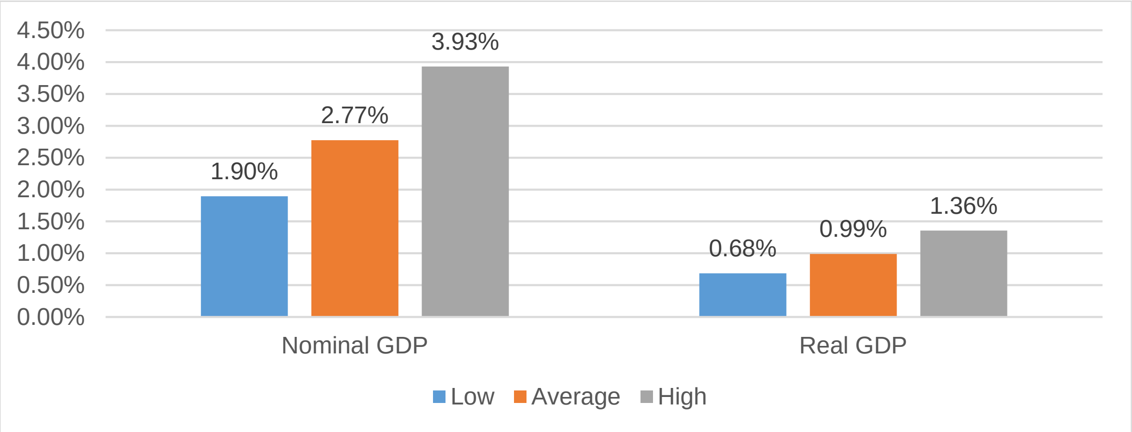
Figure 16: Benefits to PSNP households and others, by region, in billions of ETB



8.4.3 Impacts on national GDP

We finally look at the overall impacts on total GDP, in other words the aggregate value added created by the PSNP in the country. Figure 17 reports nominal and real GDP increases in each of our three levels of simulation. In nominal terms, the program generates between 1.90% and 3.93%. Once we correct for changes in the value of the consumer price index, these values come down to a 0.68%–1.36% increase in real GDP terms. In the simulation using the average value of parameters we estimated, the program generates a 0.99 per cent increase in real GDP. The cost of the PSNP is roughly 2 per cent of GDP, meaning that the PSNP creates half of its cost in value added just in the first year.[18]

Figure 17: Percentage change in total GDP in PSNP simulations, nominal and real



It is important to note that a safety net program is not necessarily expected to generate any increase in GDP. The GDP can be thought of as the value added created in an economy during production of goods and services. If households receiving the transfer were spending all of that income on imported goods, they would not stimulate local production of anything except transportation and retail services, generating very limited value added. From that perspective, a 0.99 per cent increase in GDP is a sizeable achievement. It is due to the fact that the PSNP stimulates local production, both by increasing demand for locally produced crops and by boosting the yields of those crops.

[18] According to the World Bank: http://go.worldbank.org/UB7MCRDEQ0

The increase in GDP we simulate bolsters the case for the PSNP's two-pronged strategy.

9. Conclusion and discussion

Evaluating the impacts of Ethiopia's PSNP is complicated and requires the use of tools beyond conventional impact evaluation methods. Conducting an RCT evaluation was not an option, as the program was not rolled out in a random fashion to treatment and control groups. The impacts of the cash transfer component of the PSNP extend beyond the households that are treated by the program. As beneficiary households spend their cash, impacts get transmitted to non-beneficiary households, most of which are ineligible for the program. If an RCT had been an option for this evaluation, it would have had to include the ineligible households in localities treated by the PSNP in order to quantify these cash transfer spillovers.

The evaluation is further complicated in the case of the PSNP because the program includes the creation of public goods, which by their nature affect households that are not the direct beneficiaries of program transfers. In theory, the public works projects supported by the PSNP could have been chosen randomly across PSNP sites, but this makes little economic sense as it would likely lead to wasting of resource on irrelevant projects. In contrast, the PSNP builds a diversity of interventions, the selection of which reflects local needs, environments, and other considerations.

We have developed a comprehensive evaluation approach which combines case studies, econometric analysis, local economy-wide modeling, and national modeling. This approach combines the micro, meso, and macro viewpoints to comprehensively document the full impacts of the PSNP. This evaluation framework makes it possible not only to identify the likely impacts of PSNP interventions in their diversity, but also to synthetize them into a consistent framework at the economy-wide level. Eight case studies in each of four regions provided us with insights as to the diverse settings in which the PSNP operates, and let us observe the far-reaching benefits of the community assets created by the PSNP public works.

In addition to affecting the laborers who work on them, public works projects can often create impacts throughout the community. Some of those impacts are direct, such as when an irrigation project in Lemlem brings water to the fields of all households in the village. Others are less direct, as when moto-taxis use a PSNP road to get a client to a destination. Projects can also improve the agro-ecology of their regions, which affects income and income opportunities in many ways.

We tested econometrically the impact of projects on yields. While our results did not identify impacts of road building on yields, we found that the presence of an SWC project enhances crop yields by 2.8 per cent on average. We then estimated that the average irrigation project increases vegetable yields by 12 per cent in a community. The cash transfer represents 18 per cent of income for beneficiaries. Building on those statistical and econometric estimations, we simulated the economy-wide impacts of the PSNP.

Eight LEWIE models revealed significant economy-wide impacts of the PSNP. Our analysis finds evidence of sizeable income multipliers, ranging from 1 to 2.4 ETB per

ETB transferred depending on the *kebele*, and production multipliers of up to 1.4 ETB per ETB transferred.

LEWIE offers insights into the pathways through which the PSNP influences local production and incomes. Cash transfers increase the demand for local goods and services in the beneficiary households. The patterns of demand in these households determine where income is spent, the impacts on local production activities and on the households that engage in these activities, and ultimately the size and distribution of program spillovers. Public works projects that raise productivity in particular activities benefit the households that engage in those activities, many or most of which do not benefit directly from the PSNP transfers. Higher productivity increases the local supply response, making it more likely that the PSNP transfers will generate large local income multipliers.

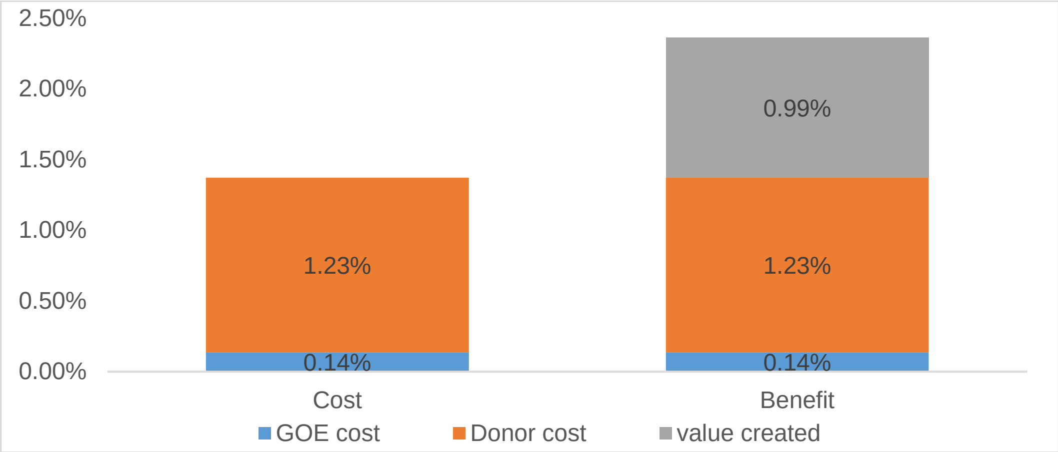
Nevertheless, the program multipliers vary considerably across locales, and by the kinds of constraints that beneficiary and non-beneficiary households face, which influence the local supply response. In some communities, the lack of spillovers translates into a real income loss for non-beneficiaries. While non-beneficiary households are less poor than beneficiaries, they are still living in some of the most food-insecure communities in Ethiopia, and most of them are indeed poor – just not poor enough to benefit from the transfer. Even if the benefits to recipients outweigh the losses to non-recipients, the fact that the program has the potential to harm them should not be overlooked.

The more closely localities are economically integrated with outside markets, the greater the PSNP leakages are, and the smaller the transfer multipliers. Total income multipliers drop dramatically in the most integrated communities. Access to outside markets, while reducing local PSNP multipliers, can provide producers who can take advantage of these markets with income opportunities not available in more isolated localities. Thus, it is wrong to conclude that lower multipliers are necessarily a sign of failure for the program. Rather, it is an indication that in localities that are more integrated with outside markets, we need to cast our net more widely in order to capture program spillovers. We capture all the spillovers with the national CGE model.

Simulating the PSNP at the national scale with a CGE model revealed that the program creates sizeable nationwide spillovers. This reflects the unusual size and scope of the PSNP, the largest program of its kind in Africa. While PSNP beneficiaries see the largest income benefits in percentage terms (14% of real income), the impacts on supply, demand, wages, and prices mean that the rest of the country experiences real income benefits of up to 2%–4%. Such results can bolster support for the PSNP among beneficiaries and non-beneficiaries alike.

We find that the program increases national value added by 0.99 per cent. The cost of the PSNP transfers in our model amounts to 1.37 per cent of GDP (this is in line with available estimates, which put it at 1%–2% of GDP depending on the source). Since our simulation represents one year of the program, this result suggests that the PSNP creates over half of its own cost in value added within a year. A useful way to think about this result is depicted in Figure 18, an approximate cost-benefit analysis of the program when general equilibrium effects are taken into account. On the left, the cost of the program is 1.37 per cent of GDP. On the right, we tally up the benefits of the program, the first of which is the transfer itself (1.37% of GDP). This is a benefit as much as a cost, because the money distributed as the cash transfer is simply changing hands. In addition to that, the program creates 0.99 per cent of GDP in value added, which are the additional benefits of the program. When viewed this way, it is clear that the economy-wide benefits of the program are not to be ignored.

Figure 18: Approximate costs and benefits of the PSNP nationwide, as a percentage of Ethiopia's GDP



Note: general operating expense cost assumed to be about 10% (varies between 8% and 18% depending on source).

Our approach does have limitations. First, while part of our analysis uses econometric estimations, we also rely on simulation methods which are sensitive to model assumptions. Modeling and simulation cannot deliver the same level of confidence as econometric estimation. Still, because we feed econometrically estimated parameters to our models, and rely on Monte-Carlo methods to generate error bounds around our simulation results, this bolsters the confidence we have in these outcomes. Second, the eight *kebeles* are by no means representative of PSNP areas, and we should not attempt to generalize results obtained from such local analysis. However, the goal in using case studies is to hone in on details and provide a nuanced picture of PSNP outcomes in diverse settings, which would get obscured if we only cared about estimating average impacts.

It is also useful to note that our simulations do not take into account long-term benefits of SWC programs that gradually improve the agro-ecology of the zones they are implemented in, nor the longer-term productivity benefits of schools and clinics. They are limited to strictly economic impacts, and ignore the intangible benefits of alleviating food insecurity. Another issue we do not address is that of PSNP implementation. Our models were not designed to deal with any of the practical issues regarding the targeting of beneficiaries (fairness, corruption), the design of PSNP public works projects, or the distribution of funds. In particular, as some of the transfers are given out in cash and others in kind, the question of which is more beneficial (to recipients, and in general equilibrium terms) is of definite importance.

With these caveats in mind, our analysis still has the advantage of being the first attempt to really shed light on the broader impacts of the PSNP. The substantial productive and economic benefits of the PSNP we document are testimony to its ‘productive’ component. This sheds light on the first three evaluation questions we set out to answer:

1. PSNP community assets do contribute substantially to the economic growth of the local economy, particularly through their impacts on agricultural yields.
2. This benefits all households who grow crops, who are often not those targeted by the transfer itself. Measuring these spillover impacts requires a general equilibrium outlook, whether at the local or the national scale.
3. Those methods suggest the spillovers are of substantial economic importance, even at the national scale.

These results also help to answer the last of our evaluation questions, namely whether it is desirable to focus most of the evaluation of the PSNP on beneficiary graduation. Given the existence of cash transfer spillovers and of productive impacts of public works, the PSNP is contributing to the reduction of food insecurity – its primary goal – in more systemic and complex ways than just providing safety net relief. While beneficiary graduation should remain an important measure of program success, a full evaluation is required to develop indicators at the community or even the national level.

10. Specific findings for policy and practice

Our findings have some important implications for the PSNP and its implementation.

10.1 Documenting benefits of cash transfers beyond the treated

Evaluations of social programs normally look for impacts in treated households. However, our analysis points to important spillovers of PSNP cash transfers within the local economy. The total benefits of the PSNP include these spillovers. If we ignore positive spillovers, we will underestimate the benefits of PSNP cash transfers in most cases.

10.2 Garnering support for social programs

A large share of the potential spillovers from PSNP transfers is found outside the households that receive the transfers. Thus, non-beneficiaries benefit: by treating the target households, the program treats the entire local economy. Documenting benefits to non-beneficiaries is critical to garner support for this and other development programs.

10.3 Softening the trade-off between social and productive programs

Poor countries are cash-constrained and face difficult trade-offs when it comes to allocating scarce resources to social versus productive programs. Our analysis raises the possibility that social cash transfers can be effective at achieving both social and productive goals, by raising income in beneficiary households while stimulating local production. This should be good news for finance as well as social welfare ministries.

10.4 Enhancing impacts with public works projects

We document productive impacts of PSNP cash transfers even when they are not conditional upon contributing labor to public works programs. If public works projects have productive impacts of their own, these will add to the positive spillovers created by PSNP transfers. We find evidence that PSNP projects observed on the ground generate large income and production multipliers in project areas – including for households that are not direct beneficiaries of the PSNP.

10.5 Cash or kind?

The PSNP includes aid in kind (food). In general, in-kind aid does not benefit local economies in the way aid in cash does, unless the food distributed by the program is acquired from local producers. It can adversely affect local economies by increasing the food supply and depressing food prices. We find that the multiplier effect of PSNP cash transfers varies considerably across *kebeles*. On one hand, this might suggest that the use of food aid has a high opportunity cost in some *kebeles* (those with high cash-income multipliers) but a low opportunity cost in others (those with very low multipliers). On the other hand, low income multipliers may reflect other constraints that could be alleviated by the PSNP and complementary interventions.

10.6 Constraints

One goal of PSNP public works projects is to alleviate local production constraints. In this sense, there is potentially a strong complementarity between the public works and cash transfer components of the PSNP: the first may increase the local income multipliers generated by the second. Not all of the constraints on production in poor economies are addressed by PSNP public works projects, however. In particular, liquidity and risk constraints on local production make the local supply response inelastic and can dramatically reduce the income multipliers created by the PSNP.

Most of the local multiplier effect of the PSNP depends on a robust supply response in the households that *do not participate in the program*. Most of those households are poor – just not poor enough to qualify for PSNP assistance. Enabling ineligible households to overcome the constraints on their production activities is critical in order for the PSNP to generate large local income and production multipliers. We encourage the government and donors to consider microcredit and other interventions aimed at PSNP-ineligible as well as PSNP-eligible households as a complement to the program.

Online appendices

Note to the reader: Online appendices are provided as received from the authors. They have not been copy-edited or formatted by 3ie.

Appendix A: Shares of output coming from PSNP areas, by agro-ecological zone

This appendix is only available online and can be accessed from http://www.3ieimpact.org/sites/default/files/2019-01/appendix-a-ie66-ethopia.pdf

Appendix B: LEWIE model

This appendix is only available online and can be accessed from http://www.3ieimpact.org/sites/default/files/2019-01/appendix-b-ie66-ethopia.pdf

Appendix C: Accounts in the national PSNP SAM

This appendix is only available online and can be accessed from http://www.3ieimpact.org/sites/default/files/2019-01/appendix-c-ie66-ethopia.pdf

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The Productive Safety Net Program (PSNP) was launched in 2005 to fight chronic food security issues in Ethiopia. The program falls under the work-for-food category where community members receive cash transfers in lieu of working on projects. The dual nature of the PSNP, combining delivery of safety net protection with the creation of productive assets in the community, covers about 10 percent of the population and potentially has manifold effects. In the past, however, the studies did not address impacts beyond the beneficiary households. This study fills this gap by evaluating the impacts beyond the receipt of cash transfers, by using the local economy-wide impact evaluation(LEWIE) model. Although LEWIE estimates large variations across kebeles (neighorhoods), the authors found significant income and production multiplier effects due to the cash transfers. Thus, both PSNP beneficiaries and non-beneficiaries were impacted by the program.

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