RETHINKING APPROACHES TO FOOD SECURITY AND POVERTY IN DEVELOPING ECONOMIES

by

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(Under the Direction of Santanu Chatterjee and Laura V. Zimmermann)

Abstract

A significant amount of redistribution takes place through food security programs in developing countries. Yet, the role played by these policies in poverty alleviation has been largely ignored, especially in empirical economics. In my dissertation, I study the need for and the ideal design of a food security policy in the context of poverty alleviation in developing countries. Specifically, I analyze the following questions - Should food security legislation follow a targeted approach or aim for universalization? How do in-kind transfer programs compare with cash transfer programs? What aids or hinders the working of these programs? These questions have been relatively untouched in the literature. The objective and motivation of my dissertation is to fill these gaps in the literature.

In answer to my first question, I find that a more universal approach to food security is more successful in poverty reduction, and the driving force behind the welfare benefits under a universal system is lower Type I errors. Households use the food subsidy to make various types of risk averse investments, all of which protect them in contingencies and reduce their vulnerability to poverty. They also increase their labor supply in their primary occupation and reduce the number of casual jobs they take up, thereby reducing variability in income and making them less vulnerable to poverty. These results indicate, that not only are food security measures sufficient for poverty alleviation, but a more universal approach is more effective, at least in the context of developing countries. In answer to my second question, I find that cash transfers are more successful in poverty reduction for conditional food security programs. Contrary to previous research, cash transfers have no significant impact on prices, but marginally raise consumption of temptation goods. This indicates that a combination of food and cash transfer implementation of a food security program has considerable appeal. In answer to my third question, I find that effectiveness of a food security measure in pushing an economy out of a poverty trap depends critically on the level of infrastructure in an economy. While raising the subsistence level of food is necessary, it is not sufficient, for the economy to get to a high-income equilibrium. My model indicates that foreign aid would be most effective in eliminating a poverty trap as there wouldn't be the detrimental effect of increased taxation on savings.

If taken seriously, the results of this dissertation would justify expanding the reach of food security measures as a necessary means of income support and social protection for the poor in developing countries.

Index words: food security, vulnerability, poverty

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To my parents

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Chapter 1

Introduction

Food insecurity is a fundamental cause of poverty, that in turn makes the poor unproductive, so that they remain poor. Hence, the two primary sustainable development goals adopted by world leaders, 'Zero Hunger' and 'No Poverty', are interdependent. Despite enormous progress being made on the previous set of global goals, the reality is that millions of people today continue to live in chronic poverty and hunger. Looking at cross-country data, we find that higher levels of poverty are linked with higher prevalence of undernourishment, a consequence of food insecurity. For instance, in Rwanda, in Sub-Saharan Africa, 52%, and in India, 48% of children under the age of five were stunted (UNICEF 2009), while about 45% and 30% of the population was living below the national poverty line, as of 2009-10 (World Bank). As the poor spend a large part of their budgets on food, it then becomes necessary to question whether by subsidizing their food and generating additional income for them (a food security intervention by government), their living standards can be improved (poverty reduction). Bishop et al (1996) provide evidence in favor of this. They find that the Food Stamp Program in the United States reduced the income deficiencies of the poor (poverty gap) consistently across time in the 1980s and 90s. Thus, it is possible to move closer to both these sustainable development goals, with one right kind of strategic welfare intervention.

Yet, the role played by food security policies in poverty alleviation has been largely ignored, especially in empirical economics. In my dissertation, I study the need for and the ideal design of a food security policy in the context of poverty alleviation in developing countries. Specifically, I analyze the following questions - Should food security legislation follow a targeted approach or aim for universalization? How do in-kind transfer programs compare with cash transfer programs? What aids or hinders the working of these programs? These questions have been relatively untouched in the literature. The objective and motivation of my dissertation is to fill these gaps in the literature.

Chapter 2 tackles the debate about which implementation strategy is more effective in developing countries: a universal approach, under which households of all income categories have access to the benefits of the program, or a targeted approach, under which only poor households are eligible, and provides an answer to the first question. I address this question in the context of the world's largest food security program, the Indian Public Distribution System (PDS). The PDS provides grains at highly subsidized rates to the poor, and the extent of targeting differs from state to state within India. This provides an ideal quasi-experimental setting in South India to analyze the impact of universal versus targeted food security programs on vulnerability to poverty using a geographic regression discontinuity design. I use household survey data from the India Human Development Survey-II (IHDS II), 2011-12, for the empirical analysis. The results indicate that a more universal approach to food security is more successful in poverty reduction, and the effects are greater for the most marginalized groups. Households use the subsidy from the PDS to make various types of risk averse investments, all of which protect them in contingencies and reduce their vulnerability to poverty. They also increase their labor supply in their primary occupation and reduce the number of casual jobs they take up, thereby reducing variability in income and making them less vulnerable to poverty. These results indicate, that not only are food security measures sufficient for poverty alleviation, but a more universal approach is more effective, at least in the context of developing countries like India.

Chapter 3 tackles the debate on cash versus food transfers and answers how wealth should be distributed to the poor. Economic theory says that a cash transfer is weakly superior in terms of the recipients' utility than an equal-value in-kind transfer, as it allows recipients to switch the composition of their expenditures from food to non-food more easily. The most common explanation provided for in-kind transfer is a form of "paternalism", that is, to constrain spending on consumption of undesirable items, like tobacco and alcohol, which may be more likely with cash transfers. In this chapter I analyze whether this type of paternalism is necessary in developing countries by examining the effect of in-kind versus cash transfers on household vulnerability to poverty. Using evidence from a natural experiment in Ethiopia, where the same set of households are eligible for different types of transfer, food grains and cash, I address this question using a geographic polynomial regression. I find that cash transfers are more successful in poverty reduction for conditional food security programs. However, households receiving the cash transfer do spend marginally more on temptation items. Contrary to previous research, cash transfers also have no significant impact on prices. This research suggests that conditional cash transfers may be most successful in improving households' living standards, but at the same time food may act like an important gatekeeper. Thus, a combination of cash and food transfers under the same program framework seems to hold considerable appeal.

Finally, Chapter 4 theoretically assesses whether food security measures would enable an econ- omy to escape a poverty trap in an overlapping generations model. Specifically food security is linked to raising the level of subsistence consumption, which has an impact on human capital accumulation. The model shows that unless suitable infrastructure investment is undertaken along with food security measures, escaping the trap might not be possible. While raising the subsistence level of food is necessary, it is not sufficient, for the economy to get to a high-income equilibrium. My model indicates that foreign aid would be most effective in eliminating a poverty trap as there wouldn't be the detrimental effect of increased taxation on savings.

If taken seriously, the results of this dissertation would justify expanding the reach of food security measures as a necessary means of income support and social protection for the poor in developing countries.

Chapter 2

Whose Right Is It Anyway? Welfare Implications of Food Security Programs

2.1 Introduction

According to the FAO, one in 9 people worldwide suffer from chronic malnourishment, which make them less productive workers. As figure 2.1 shows, there is a strong correlation between malnourishment rates and poverty. Hence, food security programs may help improve living conditions, while reducing malnourishment prevalence, by giving the poor access to food at subsidized rates and allowing them to spend their money on other items. In practice, however, it is often unclear whether food security programs work as well as other anti-poverty programs, and how they should be implemented to be most effective.

The question of the best implementation strategy of a welfare program for the poor is a much debated topic, and empirical evidence on this question is scarce. Under a universal program everyone can claim the benefits of the program, whereas in a targeted program the benefits are delivered selectively to those in need. A targeted system tends to receive greater public support because it costs less in terms of expenditure on benefits and due to expectations of higher quality. However, determining eligibility for targeted programs is costly, difficult, and imperfect. This is especially true in developing countries which do not have the required administrative sophistication and capacity for identifying the poor with precision. The major advantage of universal programs on the other hand is that they are easy to administer. Arguments of proponents of a more universal system (Dreze & Khera

2010, Abreu et al 2011) are based on the premise of minimizing errors of wrong exclusion,[1] which is heightened under a targeted system. The current emphasis on targeting around the world, however, does not take into account the experience from many advanced countries, which suggests that universal systems may have underappreciated long term effects.[2]

What is the ideal design of a food security program? This is the question addressed in this paper through an analysis of India's Public Distribution System (PDS). India spends significant resources on its core safety net programs[3] - over 2% of GDP in recent years. The PDS, which has been around since the 1940s, is a government distribution network that incorporates a food subsidy and absorbs substantial public resources at approximately 1% of GDP. Currently, the generosity of the coverage and benefits extended under the PDS in India differs from state to state. In South India,[4] Tamil Nadu and Andhra Pradesh run a nearly universal PDS while in the neighboring states it is strictly targeted. The long border between South-eastern (Tamil Nadu and Andhra Pradesh) and South-western (Kerala, Karnataka, Maharashtra) parts of the country provide an ideal quasi-experimental setting for a geographic regression discontinuity (RD) design for evaluation of differing forms of the PDS, in the spirit of Dell (2010). Specifically, I examine the impacts of a more generous PDS on vulnerability to poverty of the population in South India.[5] This can then also shed light on the broader question of the impacts of universal versus targeted food programs on poverty alleviation.

[1] exclusion of the people that the government would most like to aid

[2] The experience of many European countries, for instance, suggests that universal provisioning of social services served as an important instrument for development and nation building. Many European countries, for example, introduced flat-rate pensions at a comparatively early stage of welfare state development, when these countries had the same per capita incomes that Latin American countries had in the 1980s and 1990s (Mkandawire 2005)

[3] PDS, Mahatma Gandhi National Rural Employment Guarantee scheme (MGNREG), Indira Awaas Yojana (IAY), and Indira Gandhi National Old Age Pension Scheme (IGNOAPS) among others

[4] Tamil Nadu (TN), Andhra Pradesh (AP), Kerala (KL), Karnataka (KA) and Maharashtra (MH)

[5] Vulnerability to poverty is the ex-ante risk that a household will, if currently non-poor, fall below the poverty line, or if currently poor, will remain in poverty (Chaudhuri et al 2002). See section 2.3.2 for more details.

To provide some intuition for the expected empirical impacts of a more generous PDS, I set up a social welfare maximization model. In the model, the subsidy and probabilities of errors of targeting are known but exogenous to the state, and the income cutoff for targeting the food security program is the policy parameter. The model implies that the larger the probability of errors of wrong exclusion is, the more universal a food security program should be. That is, countries should choose policies of universal access in early stages of development when poverty is widespread, which is consistent with historical evidence from developed countries. It suggests, that in countries like India, strict targeting might be unnecessary and administratively too costly.

My empirical results corroborate the model's predictions. They indicate that a household's ability to mitigate risk and cope with shocks is enhanced with a quasi-universal PDS,[6] through direct and indirect channels. Households use the subsidy from the PDS to make various types of risk averse investments, such as increasing their asset base or investing in property and livestock, all of which protect them in contingencies and make them less vulnerable to poverty. They also increase their labor supply in their primary occupation and reduce the number of casual jobs they take up, thereby reducing variability in income and making them less vulnerable to poverty. A more generous PDS reduces overall household vulnerability to poverty by around 9% for the full sample compared to a less generous PDS. The impacts are largest for the most marginalized group in my sample (SC /ST), a reduction of about 12% in the probability of becoming poor, indicating that the PDS seems to be working in the right direction. The direct impacts of an expanded PDS, on consumption and health, are less prominent though. These results indicate, that not only are food security measures sufficient for poverty alleviation, but a more universal approach is more effective, at least in the context of developing countries like India.

[6] I am categorizing a program as universal when there are no income cutoffs for eligibility (TN). A quasi-universal system would be a program with a relatively high income cutoff (AP).

My paper extends the general literature on food security programs and also the debate over universal and targeted programs. Evidence on food security programs elsewhere, such as Food For Education in Bangladesh, indicates that they have performed well, even while adopting different targeting methods (Ahmed et al 2001, Meng and Ryan 2007, Alderman et al 2010). However, these studies are usually in field survey settings where external validity may be low and scaling up differences not accounted for. The PDS is a very large program affecting millions of people in the context of a large developing country, and hence the results in this paper have greater external validity. Also, the empirical literature on the debate over universal and targeted programs has mostly concentrated on the effectiveness of different types of targeting (for instance, community based versus proxy means tested) rather than on a direct comparison of the two types of systems (Coady et al 2004, Alatas et al 2012, Bigman et al 2000, Benfield 2007). Despite the centrality of targeting in these studies, we know little about the relative effects of targeted and universal welfare policy for poverty and this paper fills this gap in the literature. The closest empirical study to this paper is Brady et al (2012), who look at the impacts of targeted versus universal social policy on single-mother poverty with a multilevel analysis across 18 affluent Western democracies. They do this by constructing an index of welfare generosity on a standardized scale based on public expenditures on various social programs as a percentage of GDP. In contrast, this paper looks at the actual eligibility criteria of a particular program to classify states as universal or targeted. This is closer to the heart of the debate since even programs with very strict rules for eligibility (and hence would be termed as 'targeted') could have very high levels of welfare expenditure.

My paper also contributes to the active literature on the PDS in India in three respects: the choice of outcome variable, the method, and the research question itself. Whereas evaluations of other programs in India, such as the NREGS, show that it is not ineffective in altering the situation of the poor despite low take up (Zimmermann 2015), the PDS has not received similarly positive reviews from economists.[7] Yet it is the most far reaching welfare program operational in India currently, in terms of coverage as well as public expenditure.[8] Existing empirical analyses on the PDS have mainly focused on consumption, nutritional and price gains and found minimal impacts (Bhalotra 2002, Kochar 2005, Tarozzi 2005, Krishnamurthy et al 2013). A few studies have estimated the impact of the PDS on poor households, in terms of reductions in the incidence and severity of poverty (Radhakrishna et al 1997, Tritah 2003), but have been unable to detect substantial effects. In contrast, by concentrating on South India, where errors in the functioning of PDS is low, I am able to isolate significant impacts on vulnerability to poverty, which may be swamped in other parts of the country. This is also the first paper to use geographic RD to study the PDS to estimate causal effect of PDS generosity, and focus on generosity differences of PDS. The geographic RD in this paper gives estimates that have greater internal validity as statistical theory shows that a correctly implemented and analyzed regression discontinuity design gives unbiased effect estimates at the discontinuity. Thus, this paper adds value to our understanding of the PDS and like Khera (2011),[9] paints a more positive picture of the PDS than most existing papers do.

The rest of the paper is organized as follows. Section 2 gives the background of the PDS and the debate, section 3 gives a theoretical model and describes my measure of poverty, section 4 provides an overview of the methodology, section 5 describes the data and empirical specification, section 6 provides a summary of the results and discusses mechanisms and

[7]Extensive research on the subject has shown (Planning Commission 2005, Advisor To The Commissioners Of The Supreme Court, West Bengal 2010, Jha and Ramaswami 2010, Khera 2011, among others), that the PDS is plagued by numerous issues in implementation, with leakages and inaccurate identification of poor households. Other studies have revealed that nearly 44 to 60% or more of the needy population are wrongly excluded in the relatively backward states of Bihar, Madhya Pradesh, Rajasthan and Uttar Pradesh (Khera 2008, Swaminathan 2008).

[8]As Khera (2011) notes,for BPL households in many states, the implicit subsidy from PDS food grains alone is roughly equivalent to a week's NREGA wages (without having to work) every month, and hence, the PDS has the potential to improve the living standards of many more. However, it is a historical institution in the country and changes were made to its functioning in an adhoc manner, which makes empirical assessments of its role difficult.

[9]Khera (2011) gives a more positive outlook on the PDS. She finds that respondents in an exhaustive nine-state PDS survey received 84-88% of their full entitlement and attributes this revival to a move towards universalism.

sources, section 7 discusses robustness checks, section 8 provides a Cost Effectiveness Analysis and finally, section 9 concludes.

2.2 Background

2.2.1 Institutional Details

In terms of availability of food, India is a food surplus nation where buffer stocks are more than two times what is required for food security (Table 2.4). Between 1950-51 and 2006-2007, production of food grains (comprising rice, wheat, coarse cereals and pulses) in the country increased at an average annual rate of 2.5% compared to the growth of population, which averaged 2.1% during this period (Swaminathan 2008). Yet, according to the Food and Agricultural Organization, India alone accounts for over 400 million poor and hungry people. The Public Distribution System (PDS) in India is a large scale producer price support-cum-consumer subsidy program that evolved in the wake of extensive food shortages and fluctuating high food prices in the 1940s. By the 1980s its reach widened considerably. Working alongside the free market, it provides rice, wheat, edible oils, sugar and kerosene at subsidized prices through 489,000 fair price shops in rural and urban areas across the country. The subsidy implied by the program has grown significantly over the years (Table 2.5), from Rs. 2,850 crore in 1991-92 to about Rs. 72,823 crore in 2011-12, an increase of over 25 times in 21 years. In 2011-12, the food subsidy implied by the program amounted to approximately 34% of total central government subsidies under non-plan expenditure and approximately 5.8% of agricultural GDP (Sharma 2012).

The government redesigned the PDS to form the Targeted Public Distribution System (TPDS) in 1997 due to poor assessments of the PDS and growing fiscal deficits. The new system distinguished between households that fall ‘below the poverty line’ (BPL) and those who are ‘above the poverty line’ (APL), and reduced subsidies to the latter, while increasing those to the former. Eligibility for APL and BPL ration cards[10] is based on the economic status of the household. Table 2.6 gives the procedure for identification of BPL households and distribution of ration cards for lifting the subsidized food. Food grains are allocated to states by the central government as per the proportion of BPL families fixed by the Planning Commission. As Table 2.6 shows, The Ministry of Rural Development uses the Planning Commission's state-wise estimates of BPL household numbers to come out with the criteria for classification of BPL families based on parameters like size of land holding, assets owned, e.t.c. Many states in India rejected the Planning Commission's norms and expanded the PDS well beyond the BPL list, like Chhattisgarh in the north and Andhra Pradesh and Tamil Nadu in the south. Table 2.7 shows the key characteristics of the PDS in South India, in terms of the eligibility and entitlements of BPL ration cards. While it is voluntary to obtain ration cards in India, states have different exclusion norms for granting BPL ration cards. Typically, to obtain a ration card, the applicant needs to present proof of identity, address and income.

For categorizing universal and targeted PDS states I employ the definitions in Vanneman & Dubey (2011). They identify middle class families as those with incomes above half and below twice the all-India median, between Rs. 6,809 and Rs. 27,235 and affluent families as those with incomes more than twice the Indian median, an average equivalence income of Rs. 54,451 annually. The middle class they identify would still be relatively poor, while the affluent class would be a more recognizable middle class with comfortable existence in the Indian context. Hence, I term the system in a state to be 'more generous' if the income exclusion cutoff is above Rs. 27,235 per annum. The rationale for using this income cutoff is the fact that India's national poverty line is too low to be acceptable in middle-income and

[10] A Ration Card is a document issued under an order or authority of the State Government, as per the Public Distribution System, for the purchase of essential commodities from fair price shops. They are an important subsistence tool for the poor as they provide proof of identity and a connection with government databases.

richer countries.[11] The ‘middle class’ line in Vanneman & Dubey (2011) is also closer to the international poverty line of $1.25 a day in 2011. Secondly, I also look at the actual subsidy received by a household with a ration card in these states. As can be seen from the extensive margins in Table 2.7, TN follows a universal PDS where anyone can get a BPL ration card. AP also has a quasi-universal system with very lenient eligibility criteria and covering over 80% of the population. These 2 states also provide substantially larger subsidies on average, as can be seen from Table 2.8. Hence I define these 2 states as having a more generous form of PDS (as a proxy for a universal food security program), while the other 3 are said to run a less generous PDS (as a proxy for a targeted food security program).

To reasonably rule out that any negligible impacts on the poor are due a dysfunctional PDS, it is necessary to concentrate on an area with a well-functioning PDS, so that it can be assumed that the subsidies are reaching the intended beneficiaries mostly. Thus, to determine the states where the PDS is working well, I focus on trends in diversion of food grains, as this has been one of the areas of major concerns for the PDS. While grains could be lost in transportation or due to poor storage, e.t.c., the general consensus has been that the grains are sold illegally on the open market. Khera (2011) finds that states can be divided into those with a functioning, reforming and languishing PDS, in terms of per capita purchase of wheat and rice and proportion of grain diverted. The states I include in my analysis (South India) are all functioning states where leakage of food grains from the PDS is not a major concern (see Table 7).

[11] As Choudhury (2011) says, even compared to less developed regions, India’s poverty line is too low. For instance, the three poverty lines in South Africa - food, middle and upper - are all higher than that of India. The food poverty line in Indian rupees was Rs. 1,841 per capita per month in 2010, middle poverty line was at Rs. 2,445 and upper poverty line was at Rs. 3,484. Per capita poverty line of a rural adult Rwandian in Indian terms comes out to be Rs. 892 per month, slightly more than Rs. 816 for a person in rural India, even though food is cheaper in Rwanda.

2.2.2 Lessons Learned from Targeting

The shift away from universalistic policies towards targeted welfare programs began in the 1980s with the rise of the neoliberal ideological shift in industrialized countries, which gave more importance to individual responsibility and promoted a limited role for the state (Mkandawire 2005). Perhaps the most serious of the criticisms levelled against universalism is that it is not redistributive unlike a targeted program which is said to generate a pro-poor distribution of social services in society. However, as Korpi and Palme (1998) argue, though targeted programs may be more redistributive *per unit of money spent*, other factors are likely to make universal programs more redistributive. This can be illustrated by means of a simple example (an extension on the work of Rothstein 2001), as shown in Tables 2.2 and 2.3. Though targeting assumes that it is possible to precisely identify the poor on the basis of factors like land and income, a targeted welfare program tends to suffer from 2 types of errors in general due to imperfect measurement. Type I errors, or errors of wrongfully excluding genuinely deserving households from a program, and Type II errors, or errors of inclusion of privileged households ineligible for the program. Excluding privileged households implies significant risk of exclusion for poor households in a targeted program. When these errors are factored in, a targeted program may not be as redistributive as desirable. As can be seen from Tables 2.2 and 2.3, under a universal program, only 40% of the taxes raised are distributed to the poor, compared to a targeted program which results in 60-100% redistribution to the poor. When targeting is absolutely precise (Table 2.3 column 5), the reduction in inequality is greater under a targeted program than a universal program. However, even the strongest supporters of targeting would contend that its accuracy is unlikely to be perfect. When factoring in a leakage to non-poor households of 40% (which is typical in developing countries), the resulting reduction in inequality is less than that under a universal system (Table 2.3 Column 7).

Another point not often highlighted in these debates is that targeting also suffers from the problem of substantial administrative and transaction costs, which may overshadow the cost of subsidies under a universal system, if the objective is to fight poverty. Accurately identifying and maximizing coverage among the poor, controlling leakage (while maintaining high rates of efficiency) and implementing well-developed fraud control, can turn out to be a very expensive process. While the exact differences in costs between targeted and universal provision is not clear, it has been argued that targeting often signifies a substantially higher cost.[12]

In the Indian context, Dreze and Sen (2013) note that India's experience with targeting has been far from encouraging, while many public policies based on the principles of universalism with 'self-selection' (like mid day school meals and NREGA) have performed comparatively well. They contend that the problems of exclusion and divisiveness inherent in targeted programs are exacerbated by the fact that India's official poverty lines are too low.

2.3 Theory & Measure

2.3.1 A Stylized Model

The government plans to put a program in place to provide food subsidy (FS), s, to the population below a certain income cutoff. Let the information to the government be that consumption (c) is distributed uniformly over the interval (0,1). Let v be the income (consumption expenditure) cutoff to get a subsidy of s. Let us consider the null hypothesis that the consumer is below the income cutoff.

Then, Type I Error (Reject null when it is true)= $p^I = P(FS = 0|c < v)$.

And, Type II Error (Fail to reject null when it is false) = $p^{II} = P(FS = s|c > v)$.

[12]In low-income countries, total administrative costs for targeted programs comes to about 30% of total costs, compared to 15% for running a universal program. Comparisons between universal and targeted programs in the United Kingdom indicated administrative costs of 3.5% for universal programms and about 10% for means-tested targeted programs. Studies from the United States found similar results (2.5% universal versus 13% targeted) - Dutrey (2007)

Then cost of subsidy to the government $= (1-p^I)vs + p^{II}(1-v)s =$ y.

Total cost of program (including administrative costs, etc) $= \gamma(y)$ with $\gamma' > 0$ and $\gamma'' > 0$.

Let the utility of an individual consumer be given by, U(c), with $U' > 0$ and $U'' < 0$.

Then, government's goal is to maximize social welfare:[13]

$$\Omega = \int_0^v U(c+s)dF(c) + \int_v^1 U(c)dF(c) - p^I \int_0^v [U(c+s) - U(c)]dF(c) + p^{II} \int_v^1 [U(c+s) - U(c)]dF(c) - \gamma(y).$$

Here, s, p^I, p^{II} are exogenous. v is the policy parameter.

Then, FOC (using Leibniz's rule):

$$\frac{\partial \Omega}{\partial v} = U(v+s) - U(v) - p^I[U(v+s) - U(v)] - p^{II}[U(v+s) - U(v)] - \gamma' s(1 - p^I - p^{II}) = 0$$

$$\Rightarrow [U(v+s) - U(v)](1 - p^I - p^{II}) - \gamma' s(1 - p^I - p^{II}) = 0$$

$$\Rightarrow [U(v+s) - U(v)] = \gamma' s \tag{2.1}$$

This is simply saying that the marginal benefit of the program should equal the marginal cost.

And, SOC is satisfied:

$$\frac{\partial^2 \Omega}{\partial v^2} = -\gamma'' s^2 (1 - p^I - p^{II})^2 < 0.$$

Then,

$$\frac{\partial^2 \Omega}{\partial v \partial p^I} = -[U(v+s) - U(v)] + \gamma' s + \gamma'' s^2 v.$$

Substituting (1), we have:

$$\frac{\partial^2 \Omega}{\partial v \partial p^I} = \gamma'' s^2 v > 0 \tag{2.2}$$

Similarly,

$$\frac{\partial^2 \Omega}{\partial v \partial p^{II}} = -\gamma'' s^2 (1 - v) < 0 \tag{2.3}$$

Thus, (2) implies that, where probability of type I error is high it is optimal to make the income cutoff as high as possible, that is, a more universal approach. (As p^I rises, marginal

[13] a 'welfarist' approach rather than 'fairness' approach, Kaplow and Shavell (2001)

cost of program falls, so v needs to rise so that the marginal benefit falls and equation (1) holds.)

And, (3) implies that, where probability of type II error is high it is optimal to make the income cutoff as low as possible, that is, a more targeted approach. (As p^{II} rises, marginal cost of program rises, so v needs to fall so that the marginal benefit rises and equation (1) holds.)

In a cross-country study of nine countries, Cornia and Stewart (1993) note that the poorer a society, the more serious will be errors of omission or undercoverage relative to the costs of leakage. Table 2.1 provides support for this intuition. It lists 8 countries with different targeted welfare programs, in ascending order of GDP per capita (that is, poor to rich). As we can see from column 3, the benefits share of the poorest quintile in total subsidies under a program rises steadily as a country gets richer. Column 6 indicates that these also translate into lower exclusion rates for richer countries. That is, the severity of undercoverage (or type I errors) of the poor in Zambia in sub saharan Africa (a less developed country) is much more than in Brazil (a developing country). Further, in developed countries, like Chile and the United States, the problem is more one of leakage (Type II error), rather than undercoverage. Thus, we can say, in developing countries, it is more likely that p^{I} will be high due to corruption and other inefficiencies, hence a universal approach makes more sense. Whereas in developed nations p^{II} is likely to be high, such that a targeted program makes more sense.

As inferred by Cornia and Stewart (1993), the exclusion errors are indeed very high for most states under the targeted PDS regime in India, a developing country. As per Planning Commission Report 2005, about 58% of subsidized grains issued from the Central Pool do not reach the target group, BPL households (type I error) and another 21% reaches APL households (type II error). This indicates that a universal approach to food security should be more effective for poverty alleviation in India. Also, studies show that there might be important spillover benefits of including more households under a social welfare program (that is, higher type II errors), especially if non-participation is the result of a ‘stigma’ or disutility associated with participation. For instance, Kochar (2005) finds that take-up rates by BPL households increase with the level of benefits provided to the non-poor under the PDS. Greater public awareness regarding consumer rights is another example of such a spillover effect, as another reason for the poor not using the PDS could be lack of awareness regarding their entitlements. For instance, Mooij (1994) examines the PDS in Kerala prior to the introduction of targeting and finds that public awareness coupled with grass roots organisations to channel consumer complaints provided an effective check and control on the functioning of the PDS, and the state had a successful system in place. Complaints by card holders are also usually taken more seriously by officials if there are greater numbers. This goes back to the argument of Korpi and Palme (1998), that encompassing institutions pool the risks and resources of all citizens and thus create converging definitions of interest which targeting might fail to achieve.

2.3.2 Vulnerability to poverty

I refrain from using the usual measures of poverty and concentrate on a relatively broader and more dynamic measure of deprivation - vulnerability to poverty, which incorporates the destitution of individuals from future shocks. Vulnerability is the prospect that an individual will fall below some norm or benchmark of welfare at a given time in the future, where the time period and welfare measure are sufficiently general. It is an ex-ante measure of a household’s well-being (unlike poverty, which is an ex-post measure).[14] The literature proposes three alternative approaches to assessing vulnerability (Hoddinott and Quisumbing

[14]Poverty and vulnerability, though correlated, are conceptually different as depending on whether a household has secure income sources, a household above the poverty line may be vulnerable, or one just below the poverty line may not be vulnerable. The presence of risk or uncertainty about the future distinguishes the two concepts. A household faces multiple sources of risk which makes its future uncertain, like weather shocks, health shocks, e.t.c. Without this risk, the two concepts would be identical. Figure 2.3 shows how a vulnerable population need not be poor and vice versa.

2003): vulnerability as expected poverty (VEP), vulnerability as low expected utility (VEU) and vulnerability as uninsured exposure to risk (VER). VEP and VEU approaches measure vulnerability at the individual level as a probability and summing up over all households gives a measure of aggregate vulnerability. VER measures do not construct probabilities, but rather assess ex post whether observed shocks generate welfare losses at the aggregate level. VEU approaches are problematic because the unit of measurement is units of utility, which many policymakers might not be familiar with and may be difficult to understand. The appropriate measure for this paper would be an ex-ante individual measure of poverty that is easy to understand. Also, a measure of vulnerability that takes account of poverty levels seems preferable. Hence, following the VEP approach in Chaudhuri et al. (2002), I define vulnerability as "the ex-ante risk that a household will, if currently non-poor, fall below the poverty line, or if currently poor, will remain in poverty."

Formally, the vulnerability level of a household h at time t is defined as the probability that the household will find itself consumption poor[15] at time t+1:

$$v_{ht} = Pr(c_{h,t+1} \leq z)$$

where $c_{h,t+1}$ is the household's per-capita consumption level at time t+1 and z is the appropriate consumption poverty line. The procedure for estimating household vulnerability follows from Chaudhuri et al. (2002) (see Appendix). The covariates to estimate v_{ht} include:

A: A set of variables indicating household characteristics, such as (i) Family size and squared (ii) Dependency ratio - child (0-14), teen (15-20) and old (60+) (iii) Proportion of adults (21-60) (iv) Age of head and squared (v) Proportion of adults illiterate (vi) Proportion of adults with primary education (vii) Proportion of adults with secondary education (viii) Proportion

[15] According to the World Bank (2000), "poverty is pronounced deprivation in wellbeing." The main focus here is on whether households have enough resources to meet their consumption needs. Poverty is then measured by comparing households' consumption with some defined threshold below which they are considered to be poor. Poverty is largely seen in monetary terms, via consumption expenditure.

of adults with some higher education (ix) Dummy for male head, whether head is married, single or divorced, self-employed with some assistance, self-employed with no assistance, salaried worker (x) Dummy for whether farming is main livelihood (xi) Per capita land area owned and squared (xii) Dummy for whether household has access to a clean water source, indoor piped drinking water, electricity, flush toilet and hand wash after defecation (xiii) Electricity hours.

B: A set of variables indicating community characteristics (at district level), such as (i) Number of public banks per 1000 households (ii) Number of private banks per 1000 households (iii) Proportion of villages with cooperative banks (iv) Proportion of villages with public buses (v) Proportion of villages with pucca (concrete) roads (vi) Proportion of villages with railways (vii) Proportion of villages with power supply.

An advantage of this vulnerability measure is that it can be estimated with cross-sectional data and the possibility of poverty traps and other non-linear dynamics are implicitly built in. However, it assumes that the distribution of consumption across households, given the household characteristics at time t, represents time-series variation of household consumption. Thus, a large sample is required for this measure in which some households experience positive shocks and others negative shocks. It also assumes economic stability and does not incorporate the possibility of aggregate shocks.

2.4 Geographic Regression Discontinuity Design

The Geographic Regression Discontinuity (RD) design leads to identification of the local treatment effect at the boundary of treated and control areas, like a standard RD design with multiple forcing variables (Keele & Titiunik, 2014). I exploit a geographic RD design that is based on four borders (KR & TN, KA & TN, KA & AP, MH & AP) between the adjacent South Indian states (see Figure 2.2(a)) The idea is to interpret the distance to the closest state border as an assignment variable that decides about the more generous versus less generous PDS 'treatment'. In implementing the geographic RD design, I use a 'naive' measure of distance, that is, the shortest or perpendicular distance to the nearest border of the opposite group from the district centroid, for computational ease. Note that the type of distance measure does not influence the geographic RD results, because in a local region of the border they would be highly correlated (Agrawal 2015). Districts with a negative distance to the border are located on the more generous PDS side from various state borders. The treatment effects are then estimated by pooling the data around the common boundary.

The use of distance can be justified as follows. Rice and wheat are the staple food grains of the people in India. The deltaic tracts of the rivers Krishna, Kaveri and Godavari are major rice producing regions in South India (see Figure 2.2(b)). While differences in rice production may not be much when distance increases marginally, as Figure 2.6 shows, rice yield per hectare is a monotonically decreasing function of the distance from the deltas when we take distance between district centroids. Conversely, we would also expect the average cost of procuring rice to increase monotonically with distance from the deltas. Hence, while regions on either side of the boundary would have similar climatic conditions, the treatment states (TN & AP) are characterised by a relative abundance of rice as compared to the control states (KL, KA & MH). Since the grains each state receives from the Central Pool for distribution through the PDS depends on the estimates of BPL population in each state, this would mean that a state which wishes to follow a more generous system would need additional means of procuring extra grains. But for districts in control states far away from the boundary it will be expensive for the state government to buy rice locally, whereas for districts within treatment states it will be much cheaper. Thus, we can hypothesize, that state governments in treatment states optimally introduced a more generous PDS than control states because the average cost of procuring additional rice is much lower. However, while distance from the deltas increases monotonically, the boundaries between states is random (that is, independent of rice production) in the sense that they were determined by The States Reorganisation Act, 1956, which organized the provinces under British India along linguistic lines.[16] This would mean that we can think of the distance measure intuitively as an instrument for PDS generosity, with the border acting as a line of 'random cutoff', so that it would be simply luck which determines whether a household ended up getting the more generous PDS.

Another concern that arises in the case of geographic RD designs is whether to assume that treatment assignment occurs at the individual level or at a more aggregated level of geography, analogous to the choice between the unit of randomization versus the unit of analysis in a randomized experiment. In this case, while the treatment is administered at the level of the state, the treatment status units are households. A more disaggregated unit of analysis gives more power. Since households choose to live on one side of the boundary by chance, an individual-level assignment mechanism can be applied here. Figures 2.4 and 2.5 show the discontinuous jump at the boundary in the two proxies for generosity at the individual level that can be used - the proportion of BPL ration card holders and the average PDS subsidy received by the household in the district. The second, the PDS subsidy the household is getting, is a more direct measure of generosity, since it captures the actual assistance extended by the PDS. The first, whether a household has a BPL ration card, is a more indirect measure of generosity. But it captures both the ease with which a poor household can get subsidized food in a state and also the entitlements (so both the intensive and extensive margins), and hence I use the ration card information. Figure 2.4 shows that, on average, the proportion of BPL ration card holders increase by roughly 0.4 at the boundary. Relative to the level at the less generous side, this translates approximately to an 80% increase. Since the jump is not from 0 to 1, the appropriate method would be a fuzzy RD.

[16]When India gained independence in 1947, the grouping of the states was done more on the basis of historical and political principles, involving the reduction of princely states from 571 to 27. Language was decided as the basis on which India's states were to be reorganised due to popular demand and also because linguistic regions were geographically contiguous and this made them easily governable. The States Reorganization Act was passed by parliament in November 1956. It provided for fourteen states and six centrally administered territories. The state of Bombay was further split into two states, viz, Maharashtra and Gujarat, in 1960.

The assumptions for a geographic RD framework to be valid are analogous to those in a regular RD model. First, given that treatment assignment in a spatial RD design is non-random, households must not sort conditional on generosity of PDS. This is unlikely here, since obtaining a BPL ration card and availing subsidized rations in a state requires one to be a resident of the state, along with other eligibility criteria (Table 2.7) and the markets are segregated. Also, as can be seen from Table 2.8, the mean years a household has resided in a place is over 70 in all states and the expansion of the PDS in India began around 2006-07 in most states. Checking the sample for migration statistics, this assumption seems valid. About 6% of the sample migrated from another state or country (177 households). Out of this, only about 26% (45 households) have been in place for less than 20 yrs (that is migrated after 1997, when targeting was introduced). Out of this only 12 households migrated to AP or TN (the more generous states). So a strategic move due to a difference in PDS generosity is not likely to be a concern.

Second, in a standard RD design, beyond the treatment status variable, no other relevant variable should change discontinuously at the boundary. However, in a geographic RD design, we are often confronted with the problem of compound treatments, where extraneous factors also change discontinuously at the border such that isolating the effect of the treatment of interest becomes impossible. To assess the validity of the identifying assumptions, Figure 2.7 provides graphical evidence on placebo tests that explore possible discontinuities in key observable household characteristics which could be driving the results. The graphs indicated that my conjecture on the similarity of South Indian states is correct since these variables appear to be quite continuous at the border. This does not rule out that there are differences on some unobservables between the states, but this is likely to be minimal since I have isolated the southern states which are comparable on geographic, demographic and development indicators, while the differences between the north and the south in India on these parameters are much more. These states have similarly high incomes per capita and net state domestic product per capita, infrastructure, advantageous location in terms of access to sea, primary language spoken belong to the same language family (Dravidian), and each state has at least two dominating political parties. However, as Figures 2.4 and 2.5 show, we have discontinuities in two potential treatments for the generosity of the PDS at the boundary. Since the results change only marginally with the use of either treatment status variable, we can say that the Compound Treatment Irrelevance assumption (Keele & Titiunik 2015) holds here and identification is possible. That is, I can assume that there is no separate subsidy effect on outcomes, so that the generosity of PDS impacts can be exactly reduced to the BPL ration card treatment. Another possibility of compound treatments arises when two or more geographic boundaries coincide, such as a county and an electoral district. In India, however, parliamentary and district borders overlap but do not coincide exactly, and parliamentary borders do not cross state borders. Further, since I am looking at state borders, this is not a concern here since moving from a district located at the border of one state into a district on the other side of the border in a different state, would still give us the effect of the state. Thus, it seems unlikely that there is systematic sorting into treatment and we can be reasonably confident that the identifying assumptions are fulfilled.

2.5 Data & Empirical Specification

2.5.1 Data

The analysis uses the India Human Development Survey 2012 (IHDS II) data, which was collected between January 2011 and March 2013. It is a nationally representative, multi-topic survey of 42,152 households in 384 districts, 1420 villages and 1042 urban neighborhoods across India. Two one-hour interviews in each household covered health, education, employment, economic status, marriage, fertility, gender relations, and social capital. Children aged 8-11 completed short reading, writing and arithmetic tests. These data are mostly re-interviews of households interviewed for IHDS-I in 2004-05. The sample for IHDS-I was drawn using stratified random sampling and contains 13,900 rural households who were interviewed in 1993-94 in a previous survey by NCAER and 28,428 new households. IHDS II re-interviewed 83% of the original households as well as split households residing within the village and an additional sample of 2134 households. IHDS was jointly organized by researchers from the University of Maryland and the National Council of Applied Economic Research (NCAER), New Delhi.

I restrict my sample to the five South Indian states, TN, AP, KR, KA and MH which generates a sample of 12,929 households. I also use Census 2011 data for generating community characteristics for estimating vulnerability. These were aggregated to district level from village level data released under the Census, and then merged with the main data. I use the 2011-12 state wise poverty lines based on MRP consumption published by the Reserve Bank of India, as they are the most recent estimates available. Lastly, I use the 2011 Consumer Price Index (base year 2010) from Ministry of Statistics and Program Implementation, India, to deflate consumption and poverty lines.

2.5.2 Empirical Specification

In estimating treatment effects at the cutoff, the preferred way in the literature is to run local linear or polynomial regressions on a restricted sample of observations close to the cutoff.[17] The main concerns with estimating the model is to choose the size of the bandwidth within which to restrict the model to find an optimal balance between precision and accuracy. Using a larger bandwidth yields more precise estimates, since more data points are used in the regression. However, the linear specification is less likely to be accurate, which can lead to bias when estimating the treatment effect. A solution is to try more flexible specifications by adding higher order polynomials in the running variable.

[17] Estimation of RD designs have been increasingly viewed as a nonparametric estimation problem, starting with Hahn et al (2001), since misspecification of the functional form can induce large bias in RD estimates of treatment effects.

The two main types of RD design considered in the literature are the sharp and fuzzy RD designs (Lee & Lemieux 2010). With a sharp design, the treatment variable x_i depends in a deterministic way on some observable variable z_i, such that $x_i = f(z_i)$, where z_i takes on a continuum of values and there is a known point of discontinuity in the function, z_0. With a fuzzy design, x_i is a random variable given z_i, where the conditional probability $f(z_i) = E[x_i|z_i = z] = Pr[x_i = 1|z_i = z]$ has a discontinuity at point z_0. Unlike the sharp design, in the fuzzy design, there are additional unobserved variables that determine treatment and treatment assignment is not a deterministic function of z_i. The common feature in the two designs is that the the probability of receiving treatment, $Pr[x_i = 1|z_i]$, viewed as a function of z_i, has a discontinuity at z_0 (Hahn et al 2001). In other words, in a sharp design, the probability of treatment jumps from 0 to 1 when z_i crosses the threshold z_0, whereas a fuzzy design allows for a smaller jump in the probability of treatment. Since the probability of receiving a BPL ration card jumps by less than 1 at the threshold, in this case, the appropriate model would be a fuzzy RD design.

When the identifying assumptions hold, estimating the treatment effect in the fuzzy RD design is analogous to the 'Wald' formulation in an instrumental variables setting using two-stage least-squares (Berger et al. 2015). Specifically, the fuzzy RD design can be described by the following 2 equations:

$$bpl_{ij} = \lambda_0^g + \delta^g D_j + \sum_{k=1}^{\bar{k}} \lambda_k^g dist_j^k + \sum_{k=1}^{\bar{k}} \zeta_k^g (D_j \times dist_j^k) + \epsilon_{ij}^g \tag{2.4}$$

$$y_{ij} = \lambda_0^y + \delta^y D_j + \sum_{k=1}^{\bar{k}} \lambda_k^y dist_j^k + \sum_{k=1}^{\bar{k}} \zeta_k^y (D_{ij} \times dist_j^k) + \epsilon_{ij}^y \tag{2.5}$$

where the subscripts refer to household i in district j, y is an outcome variable of interest, bpl is an indicator variable for whether a household has a BPL ration card, D is a dummy variable indicating whether a district is located on the more generous PDS side of the boundary, $dist$ is the distance to the nearest border. Here, we are instrumenting bpl with D and (2) is just the reduced form equation. Both equations include trends in distance (up to polynomial degree $\bar{k}$), which will capture any unobserved factors that vary with the distance and potentially influence outcomes. We can then obtain the Wald estimator for the local average effect of generosity of PDS on outcome y as:

$$\beta^{RD} = \frac{\delta^y}{\delta^g}$$

The literature provides alternative methods for bandwidth selection,including plug-in rules and cross-validation procedures. I implement the bandwidth procedures proposed by Imbens and Kalyanaraman (2012)[18] and Calonico et al. (2014)[19], respectively. Since these might lead to bandwidth choices that are too large for conventional confidence intervals to be valid, for robustness checks, I use a simple but ad-hoc procedure to select a smaller bandwidth than the 'optimal' bandwidth (Keele & Titiunik, 2015) and check the consistency of my results. Another approach is to fit higher order polynomial regressions in a wide window. I incorporate both of these. For the local linear regressions, I restrict my model to a smaller window than the 'optimal' bandwidth. Then I increase window with the degree of the polynomial. The results do not vary substantially.

2.6 Results

2.6.1 Main Results

Tables 2.10 to 2.12 and Figure 2.8 to 2.9 give the results for the impact of the generosity of the PDS on the full sample and 2 sub groups which can be identified as relatively weaker sections of the society. The sub groups are - Scheduled Castes(SC)/Scheduled Tribes (ST) and Other Backward Class (OBC).[20] From Table 2.9, we can see that SC / ST are the

[18] optimal bandwidth selection procedure by asymptotic mean squared error minimization for local-linear estimators

[19] alternative asymptotic approximation for bias-corrected local polynomial estimators

[20] These are official designations given by the GOI to various groups of historically, socially and educationally disadvantaged people in India who are the primary beneficiaries of many reservation

more vulnerable group of the two and they have significantly lower wealth. Though OBC is categorized as a more vulnerable group in society, in the data we find that they are similar in characteristics to the average household in the full sample. As a result, the impacts on this group is similar to that of full sample. Hence, I omit a separate discussion of the impacts on this group. In all tables, one observation is a household.

Table 2.10 gives the impacts of generosity of PDS for the 3 samples and demonstrates that a more generous PDS has a relatively large impact on household vulnerability to poverty: the typical estimate is negative and relatively large in magnitude and statistically significant. Each row presents the impact of generosity of PDS on vulnerability for a different parametric functional form of the running variable. I concentrate on summarizing the results for polynomial of degree two[21] and bandwidth choice by Calonico et al.(2014). Column 1 looks at the estimates for the full sample and the coefficient in row 2 indicates that a more generous PDS leads to a reduction of household vulnerability by 0.085 percentage points. This suggests that being in a state with more universal approach to PDS reduces the average households probability of becoming poor within the next year by approximately 9%. This translates into a reduction of 51% in poverty since mean household vulnerability for the full sample is 0.168, and the effect is statistically significant at the 1% level. Column 2, row 2, of Table 2.10 reveals that the generosity of PDS impact on vulnerability of SC /ST is negative and statistically significant at the 10% level. A more generous PDS leads to a reduction of household vulnerability of the SC /ST group by 12%. This translates into a substantial reduction

policies under the Constitution in education, scholarship, jobs, and so on. Ancient Indian society was divided into four varnas, or categories, high to low they are: Brahmin (priests), Kshatriya (warriors), Vaishya (merchants or traders), and Shudras (laborers). An unofficial fifth category were the Dalits, or untouchables, a group so low that its members were assigned jobs like cleaning latrines, sweeping the streets, tanning hides and handling the remains of the dead. Untouchable castes became a category as avarnas (without varna). These ancient categories are not the same thing as the caste system, but they undergrid it. In 1935, the new term "scheduled castes" replaced the use of the term "untouchable". OBC comprises the non-untouchable communities who are socially and educationally (rather than historically) disadvantaged or "backward" in comparison to the higher castes (typically, these households would be from Shudra and Vaishya castes). The scheduled tribes are aboriginals, criminal tribes, nomads, e.t.c. (Wikipedia).

[21]since this gives the most consistent results for a wide range of bandwidths

of 57% in poverty since mean household vulnerability for the full sample is 0.205. As SC /ST is the most marginalized group of the three, we would expect that a more generous PDS would ideally have the largest impact on this group, and this seems to be the case.

Table 2.11 gives an occupational decomposition of the impacts of the generosity of PDS on vulnerability for the full sample. I consider seven separate groups by occupation, all of which have mean vulnerability greater than average for the full sample. In the table, these occupations are listed in order of mean vulnerability, high to low. The impact of the generosity of PDS ranges from 4 - 35% across groups, but there is no clear pattern visible. In almost all cases the impacts are larger than the average impact on the full sample, indicating that the PDS is indeed reaching the weaker sections of society. However, agricultural wage laborers are an exception. This is the most vulnerable group and yet the impacts are lowest here at 1% and also not statistically significant. The second most vulnerable group are landless construction workers and here we find the largest impacts of a more generous PDS. A more generous PDS leads to a reduction of household vulnerability of landless construction workers by 37%, and the impact is statistically significant at the 10% level. Comparing the first two groups, with a marginal difference in mean vulnerability, what stands out is the extent of urbanization. Agricultural wage laborers are mostly concentrated in rural areas, whereas a large proportion of the second group is living in urban areas (a difference of over 30% in extent of urbanization). One explanation is the commonly held belief that the PDS in India has a strong urban bias (for instance, it could be that rural areas have much fewer fair price shops than urban areas). However, from Howes & Jha (1992), we see that for the South Indian states, the average urban dweller does not seem to gain more than the average rural dweller from the PDS. Then, the second explanation could be that urban areas provide access to infrastructure facilities and other opportunities, that complement the effects of the food subsidies. It is possible that urban areas provide easier access to fundamental infrastructure facilities (like basic sanitation facilities and clean water), which is required for the effects of proper food intake to come through. The trend can be noticed in other occupations as well.

Non-agricultural wage laborers and automobile drivers are largely concentrated in urban areas, and the impacts on them are large and significant (12% and 26% respectively).

Table 2.12 decomposes the impacts of the generosity of PDS on vulnerability by poverty thresholds.[22] I consider the impacts on thresholds around two poverty lines - the national poverty line of Rs. 12,000 per annum and an approximate international poverty line ($1.25 a day) of Rs. 27,235 per annum. The mean income per capita in my sample is Rs. 30,655, and households are concentrated closer to the international poverty line. Thus, the income bands I consider are larger around the international poverty line (± 10,000) and smaller around the national poverty line (± 5,000). Comparing the first two columns of the table (Threshold 1 and 2) gives us the lower and upper income bands around the international poverty line. The estimates are more precise here than around the national poverty line (Thresholds 3 and 4). Two things stand out. Firstly, the impacts across all thresholds are larger for SC / ST /OBC, which is consistent with the findings of Table 2.10. Secondly, if we order the thresholds according to income distribution, we find the largest impacts are on the middle income groups (Thresholds 1 and 4), rather than the top and bottom of the distribution (19 - 23% for SC / ST /OBC). Also, the impact at the bottom of the distribution is larger than at the top of the distribution for SC / ST / OBC (16% versus 14%). Thus, a more generous PDS seems to be having the largest impacts on the "middle poor".

These results show that the impacts of a more generous PDS on poverty reduction is significantly larger than a less generous system, with the largest impacts being on more vulnerable groups in urban areas. This indicates that lack of access to basic infrastructure facilities might hinder the effects of food subsidies, and swamp the impacts of the PDS in other areas of the country. For instance, where there are no clinics or hospitals available, or where lack of roads or bridges makes them inaccessible, people cannot access the medical services that they require to be healthy and productive, even if they have access to adequate food. This indicates that while it is important to ensure that leakages in the PDS are curtailed in other

[22] SC/ST/OBC have been combined here as one group due to insufficient data points.

parts of India, the development of fundamental infrastructure facilities, that complement the functions of food, is equally important. These results also corroborate my theoretical model's predictions, that is, in a developing country like India, a more universal approach to food security is more welfare enhancing.

2.6.2 Mechanisms

The above results show empirical evidence regarding *what* effect the generosity of PDS has on vulnerability to poverty. Here, I will explore *how* the generosity of PDS affects vulnerability, that is, the potential channels through which the effects operate.

From Table 2.13 we see that PDS subsidy only marginally impacts consumption and savings (less than 0.5%), and the impacts are not statistically significant. Hence we can infer that the gains of the food subsidy is being transferred elsewhere. This could be either towards paying off outstanding debt or in some form of investment. For those households repaying loans (19% of sample), the average debt size in the data is Rs. 10,503 and the average monthly rate is 2.4%, which implies a monthly payment of around Rs. 252.[23] The average PDS subsidy in the generous states is Rs. 380 (about \$6) per household per month. Hence, at a minimum, households must be investing around Rs. 128 (about \$2) in the generous states per month. However, 81% of the sample is not repaying loans, and hence would be investing almost the entire amount of the subsidy.

From the data, I find significantly positive impacts on certain types of asset accumulation. With only 58.7% households with access to formal banking services as of 2011 (RBI Report 2013) the poor in India have to resort to creative ways of saving their spare cash, like keeping money with relatives or neighbours. Though all 5 states have a moderate to high degree of financial inclusion (51% of households have bank accounts in the sample), it is possible that most bank accounts lie dormant as has been seen in previous research (Dupas and Robinson

[23]assuming the household only pays the interest accruing on the loan each month

2013). Columns 3 - 5 of Table 2.13 looks at impacts of the generosity of PDS on three different modes of saving typically used by the poor in India, and finds significant impacts on all three. The variable 'Wealth' is a wealth index calculated using data on a household's ownership of selected assets (such as television and cooler, materials used for housing construction, types of water access, sanitation facilities, e.t.c) by the method of Principal Component Analysis. The variable 'Investment' is an indicator variable for whether the household has bought property or expanded property or invested in Pension Fund/LIC/Other savings schemes. The variable 'Livestock' gives the number of draft animals, goats, and poultry owned by the household. The impacts on the full sample are given in row 1. Column 3 indicates that households in the states with more generous PDS increase their wealth holding by 2.1%, and this is significant at the 1% level. The coefficient in Column 4 indicates that being in a state with more generous PDS increases the average household's probability of making investments by 19.9 percentage points. This translates into an increase of 71% since mean investment is 0.281, and the effect is statistically significant at the 1% level. Finally, the coefficient in Column 5 indicates that households in states with more generous PDS increase their livestock holding by 2.686 animals, and this is significant at the 1% level. This translates into an increase of 99% since mean livestock holding is 2.72 animals. As Banerjee and Duflo (2011) observe, decisions to save require a certain amount of self control from rich and poor alike. However, while the rich have a variety of tools at their disposal, like banks and financial advisors, to aid them in the process, the poor have to do a much harder job from their limited resources. Hence, investing in relatively illiquid assets, like livestock, durable goods, property, e.t.c., makes it easier for the poor to forgo "temptation" spending (like alcohol, cigarettes, tea, snacks) and force them not to be "myopic" about the future. All of the above are also relatively risk free forms of investment. This makes sense since poor people are very likely to be risk-averse, since losing money could mean starving as they have limited access to sources of credit. Thus, a more generous PDS seems to be aiding in the process of resource allocation towards relatively low-risk investments, which in turn is protecting the poor from shocks in income, and hence reducing their vulnerability to poverty.

One of the criticisms levelled against welfare programs, no matter how broadly targeted, is that of “perverse incentives” created by changes in the behaviour of households attempting to become beneficiaries of welfare policies, especially through disincentive effects on the labour supply of the poor. Households may avoid activities that improve their living standards in order to remain eligible for public support. To test for this under a more generous regime of the PDS, I look at the impact of the generosity of the PDS on labor supply and casual employment. The variable ‘Labor Supply’ is the number of hours in a day worked by an individual in a household in their primary occupation. The variable ‘Casual Jobs’ is the number of casual jobs (casual daily, casual piecework, contract $<$ 1 year). The typical individual in a household in the sample works 109 days a year (or 3.6 months) for 7 hours a day. Averaging over a year, the mean hours worked by an individual comes to be 2 hours. About 75% of the households have at least one casual job and about 5% have more than 3. The mean number of casual jobs taken up by households is 1.4. Table 2.13 Columns 6 and 7 give the coefficients of interest. The coefficient in Column 6 indicates that a more generous PDS induces households to supply 0.668 hours of a day (40 minutes) more of work, and this is significant at the 1% level. This translates into an increase of 33% in labor supply or the number of hours worked in average. Over the 3 and a half months work window, this translates into an average increase of roughly 2 hours of work, leading to a daily average labor supply of 9 hours. At the same time, a more generous PDS induces households to reduce casual employment by 0.365 jobs, and this is significant at the 1% level (Column 7). This translates into a decrease of 26% in casual employment. Ghose (2004) shows that a combination of low wage and high underemployment generates the the highest incidence of poverty among casual labourers across employment categories. Thus, a more generous PDS is making it possible for households to allocate their time more efficiently, when they don’t have to worry about putting food on the table. In 2011-12, the average daily earnings of a casual worker stood at Rs. 156 ($2.26), compared to Rs. 372 ($5.40) for a regular worker (India Labour and Employment Report 2014). Hence, taking up less casual employment and allocating more time to a regular job implies a gain of $3.14 per day. Taken over the 3.6 month window, an additional 2 hours in regular employment translates into a gain of Rs. 1,962 ($29) at a minimum. Spending more time in the primary occupation also implies gaining more expertise at the job, which would imply greater productivity, and hence better jobs and higher wages down the road. Hence, I find no evidence of "perverse incentives" created by a more generous PDS. If anything, with greater food security, households become more proactive in terms of work, which generates a more steady source of income and make them less vulnerable to poverty.

The impacts on SC / ST of the generosity of the PDS are largely similar to that of the full sample. Row 2 of Table 2.13 give the coefficients of interest. As for the full sample, the impacts on consumption and savings are marginal and not significant. The largest impact is on livestock holdings at an 154% increase over the mean, and the effect is significant at the 10% level (Column 5). The impact on the probability of making investments is similarly quite large - an increase of 97% over the mean, and this is significant at the 1% level (Column 4). A more generous PDS also leads to higher wealth holdings by 1.16% and the effect is significant at the 5% level. The impact on labor supply is smaller and on casual employment is larger than that of the full sample and significant at the 5% level. The coefficient in Column 6 indicates that a more generous PDS induces households to supply 0.509 hours in a day (31 minutes) more of work, which translates into an increase of 24% over the mean. The typical individual in a SC / ST household in the sample works 117 days a year (or 3.9 months) for 7 hours a day. Over the 3.9 months work window, this translates into an average increase of roughly 1.6 hour of work, leading to a daily average labor supply of 8.6 hours. A more generous PDS also induces households to reduce casual employment by 0.471 jobs, which translates into a reduction of 24% in casual employment. Taken over the 3.9 month window, an additional 1.6 hours in regular employment translates into a gain of Rs. 1,685 ($25) at a minimum. Hence, for all groups we can say that the resource allocation channel is more prominent than the time allocation channel in making the households less vulnerable to poverty with a more generous PDS.

2.6.3 Sources

In this section I will explore *why* the generosity of PDS affects vulnerability, that is, the potential sources through which poverty is impacted.

The impact on vulnerability in my main result section can be decomposed into higher benefits at the intensive and extensive margins. That is, the sources are both better/more reliable benefits under the universal system and giving more people access to the program. Since entitlements across states are similar, 'better/more reliable benefits' would translate into higher take up of rations under a universal system presumably due to less stigma associated with the program. Thus, total improvement of universal over targeted system equals the average of ***(a) Higher utilization:*** people under income v covered under both systems but better off under universal system AND ***(b) Lower Type I errors:*** people under income v who get excluded under a targeted system, but get the benefits under a universal system AND ***(c) Higher eligibility:*** people above income v who wouldn't be eligible for a BPL card under the targeted system but get the benefits under a universal system. The first is the impact at the intensive margin, while the latter two are the impacts at the extensive margin.

It is not possible to decompose these effects through my main empirical specification. Hence I use a propensity score matching technique to construct valid treatment and control groups and estimate the average treatment effect on the treated (ATT). Matching relies on the assumption of conditional independence of potential outcomes and treatment given observables, that is, the selection into the treatment should be driven by factors that can be observed. I use variables that most likely affect both treatment and the outcome variable to minimize selection bias. I first determine the probability of being selected into treatment (that is, obtaining a BPL ration card) by a logit equation and then use this probability (propensity score) to match households on either side of the border, filtering by the criteria for margin.[24]

Table 2.14 gives the results of interest for the full sample, SC / ST and OBC. All estimates are significant at the 1% level. Firstly, the overall ATT effect of the generosity of the PDS (that is, matching without filtering by criteria) by this method comes out to be 6%. This is very close to my linear geographic RD impact on vulnerability, and hence this serves as a good robustness check for my main results. We should expect the impacts at the 3 margins to average out to this number, and that appears to be the case. Column 1 gives the impacts for the full sample. Row 1 gives the impact of a more generous PDS on vulnerability due to higher utilization and the impact is 5%. Row 2 gives the impact of a more generous PDS on vulnerability due to lower Type I errors and the impact is 9%. Row 3 gives the impact of a more generous PDS on vulnerability due to higher eligibility and the impact is 3%. Thus, the intensive margin effect (a) is 5%, while the extensive margin effect (b+c) is 12%. This suggests that the bulk of the effect is coming from giving more people access to the program rather than better/more reliable benefits under the universal system. The impacts of the different sources on SC / ST (Column 2) are roughly similar.

These results also tie up well with my theoretical model. My model suggests that the driving force behind the welfare benefits under a universal system is lower Type I errors and this is consistent with my empirical finding. Thus, universal inclusion under a food security program might be the way forward for developing countries.

[24] a) HH has a BPL ration card and consumption is less than cutoff, v b) HH on the generous side of the border has BPL ration card OR HH on the generous side of the border does not have a BPL ration card due to bureaucratic reasons OR HH on the less generous side of the border does not have a BPL ration card due to bureaucratic reasons AND consumption is less than cutoff, v c) consumption is greater than cutoff, v.

2.7 Robustness Checks

Firstly, to further analyze the primary aim of the PDS of ensuring food security to poor households, I examine the impact of the generosity of PDS on malnutrition by my main nonparametric approach for the entire border. Table 2.15 gives the impacts of generosity of PDS for the 3 samples and demonstrates that a more generous PDS has a limited impact on malnutrition: the typical estimate is negative but relatively small in magnitude and statistically insignificant. For a polynomial of degree 2 and bandwidth choice by Calonico et al.(2014), the impacts range between 3 - 4%. This finding is consistent with previous studies which indicate that the impact of the PDS on household food security is limited.

Secondly, I employ a few alternative methods to test how robust the main results in my analysis are. As a first check, I apply the parametric approach in Dell(2010), which uses a polynomial in latitude and longitude.[25] As a secondary check, I use the same polynomial, but augment it with an Instrumental Variable approach (similar to the fuzzy GRD). As a third test, I employ a standard difference in difference approach based on the multiple discontinuities, in income cutoff and border. Since the income threshold which defines generosity (Rs. 27,235) would create another discontinuity in the targeted states, above which ideally no household should have a BPL ration card (while in the universal states they would). Hence, I can then look at the impact on the households below the income threshold in the generous states by applying a difference in difference approach. The fourth test simply augments the third approach by including the polynomial in latitude and longitude as a control. Lastly, I bootstrap my standard errors for my main nonparametric approach. The results are given in Tables 2.16 and 2.17. The impacts on the full sample range from 4 - 9%, which is consistent with my main results.

[25] See Dell(2010) for the specification

2.8 Cost Effectiveness Analysis

One way to encourage policymakers to use the scientific evidence from program evaluations in their decision making is to present evidence in the form of a cost-effectiveness analysis (CEA), which measures the ratio of the costs of a program to the effects it has on one outcome. This is different from a cost benefit analysis (CBA), which gives the ratio of costs to monetary value of effects on all outcomes. The advantage of CEA over CBA is its simplicity, since there is no need for making judgments on monetary value of all the benefits. It also allows the researcher to choose an objective outcome measure (Dhaliwal et al 2012).

There are 2 ways to do a CEA - a) Measure the cost for a given level of effectiveness (e.g.,cost to increase school attendance by 1 year) and b)measure the level of effectiveness for a given cost (e.g.,years of additional attendance induced by spending $100). Here I focus on the first method of CEA, that is the cost to reduce the absolute number of the poor by 1 household. The calculation is done using Borel's law of large numbers, which implies that in the long term, proportion of poor is equal to the average vulnerability of the group. Hence, taking the impacts of a more generous PDS, we can calculate the number of households saved from poverty, for the group of poor by international standards.

8350 households have income per capita less than Rs. 27,235. A more generous PDS reduces vulnerability of this group by 7% (from Table 10). Thus, 585 households (7% of 8350) would be saved from poverty by Borel's law. Average PDS subsidy per household per month(assuming 35 kgs of rice is distributed per household free of cost. Price of rice is the CIP of GOI): Rs. 5.65*35 = Rs. 198= $4. Total subsidy per month under universal coverage = K = Total sample (12,929 households) * $4. Total stream of subsidy under universal scheme in the long would equal $\frac{K}{1-r}$, where r is the real discount rate for the US. Taking a real discount rate of 10% (as per Dhaliwal et al 2012), this comes out to be $52,238. Thus, average cost of subsidy per household saved from poverty comes out to be $= \frac{\$52,238}{585} = \$89$.

Thus, the food subsidy cost to the government to reduce the absolute number of the poor by 1 household is $89. The cost calculation here only includes the cost of the subsidy and not other costs, like transportation, storage, e.t.c., so the above number will likely be higher. However, this can be taken as a minimum bound on the cost of poverty eradication through food security.

2.9 Conclusion

Using a geographic regression discontinuity design, this paper has analyzed the impacts of the generosity of the Public Distribution System (PDS) in India on vulnerability to poverty. The results suggest that the impacts of the generosity of the PDS on poverty reduction are positive and significant, but the effects on consumption and health are small and insignificant. The general qualitative pattern is robust across a wide range of empirical specifications, and shows that a more generous PDS is more effectively improving living standards of the poor. There is also some evidence that the PDS is working best in areas which have better infrastructure facilities. The results support the findings in Khera (2011) of the revival in the functioning of the PDS in recent years. The recommendation of the paper is that the Government of India should seriously consider the alternative to the Below Poverty Line Census proposed in Dréze and Khera (2010).

The results indicate that the generosity of the PDS is impacting poor households through indirect channels rather than directly through consumption. A more generous PDS induces households to allocate their additional resources towards relatively risk averse investments, like durable goods, property and livestock, which make them less vulnerable to poverty. Households in generous states also allocate their time more efficiently by reducing casual employment and increasing time spent in their primary occupation, which protects them from slipping into poverty.

At a more macroeconomic level, this paper sheds light on the debate over targeted versus universal welfare programs. Currently, the primary concerns regarding a more universal welfare program is whether it would be as redistributive as a targeted program and also one of cost efficiency. This paper provides evidence that a more universal approach is more welfare enhancing, in the context of the world's largest food security program. If taken seriously, the results would then justify expanding the reach of food security measures as a necessary means of income support and social protection for the poor in India as well as other developing countries.

Finally, there is the question of the viability of sustaining a near universal food security program in the long run. The cost of the implementation of the National Food Security Act in India is estimated to be \$22 billion (1.25 lac crore), approximately 1.5% of GDP, with projected import of food grains of about 62 million tonnes annually. As Olivier De Schutter, United Nations Special Rapporteur on the right to food, said on the eve of a high-level WTO summit in Bali, Indonesia in December 2013, "Supporting local food production is the first building block on the road to realizing the right to food, and trade must complement local production, not justify its abandonment.....They must develop ambitious and innovative food security policies that support their own production base, building on successful experiences in a growing number of countries....Food reserves are a crucial tool, not just in humanitarian crises, but in the everyday struggle to provide stable income to farmers and to ensure a steady flow of affordable foodstuffs for poor consumers, many of whom lack a basic social safety net". Hence, there is a need for policy changes at the high level, that will allow developing countries the freedom to use strategic grain reserves to help secure the right to food without the threat of sanctions under World Trade Organization (WTO) rules.

Table 2.1: Targeting Accuracy Of Poorest Quintile Across Countries

Country (1)	Program (2)	Benefits share (%) (3)	GDP per capita ($) (4)	Income share (%) (5)	Exclusion Rate (%) (6)	Error Type (7)
Zambia	Social Fund Program	25	1,310	3.81	68	Undercoverage
Sri Lanka	Food Stamps	28	3,926	7.27	31	Undercoverage
Jamaica	Food Stamps	31	5,138	5.28	30	Undercoverage
Colombia	SHIR	34	6,056	3.35	37	Undercoverage
Brazil	Bosla Escola	40	8,539	3.28	20	Undercoverage
Mexico	Oportunidades	58	9,009	4.86	-21	Leakage
Chile	SUF	66	13,384	4.63	-55	Leakage
United States	Food Stamps	80	55,837	5.1	-391	Leakage

Note: Column (6) calculated on the basis of the income transfer required to bring the poorest quintile to the international poverty line of $1.90 a day. It is calculated as follows: $(6) = [100 * \frac{1.90 - \frac{(4)*(5)}{100*365}}{1.90}] - (3)$

Source: Coady et al (2004), Castañeda et al (2005), World Bank.

Table 2.2: The redistributive effects of a universal program

Group (1)	Average Income (2)	Tax (40%) (3)	Transfers (4)	Final Income (5)
A (20%)	1000	400	240	840
B (20%)	800	320	240	720
C (20%)	600	240	240	600
D (20%)	400	160	240	480
E (20%)	200	80	240	360
Inequality	5	(=1200)	(=1200/5 = 240)	2.3

Table 2.3: The redistributive effects of a targeted program

Group (1)	Average Income (2)	Tax (20%) (3)	Transfers 1 (4)	Final Income 1 (5)	Transfers 2 (6)	Final Income 2 (7)
A (20%)	1000	200	0	800	64	864
B (20%)	800	160	0	640	64	704
C (20%)	600	120	0	480	64	544
D (20%)	400	0	240	640	144	544
E (20%)	200	0	240	440	144	344
Inequality	5	(=480)	(=480/2 = 240)	1.8		2.5

Note: Inequality = Ratio of incomes between groups A and E. Final Income is the income after deducting taxes and adding transfers. Source of Table 2: Rothstein (2001). Table 3 assumes a proportional tax system of 20%, where the bottom 2 quintiles are not taxed. The target for transfers are groups D and E. Column (6) assumes that targeting is imperfect, that is there is a leakage of 40% to non-poor groups (A, B and C), and the poor (D and E) get only 60% of the transfers.

Table 2.4: Stock Position of Wheat and Rice in the Central Pool vis-à-vis Minimum Buffer Norms

(lakh tonnes)

As on	WHEAT		RICE		TOTAL	
	Minimum Buffer Norms	Actual Stock	Minimum Buffer Norms	Actual Stock	Minimum Buffer Norms	Actual Stock
January 2009 #	112	182.12	138	175.76	250	357.88
April	70	134.29	142	216.04	212	350.33
July	201	329.22	118	196.16	319	525.38
October	140	284.57	72	153.49	212	438.06
January 2010	112	230.92	138	243.53	250	474.45
April	70	161.25	142	267.13	212	428.38
July	201	335.84	118	242.66	319	578.50
October	140	277.77	72	184.44	212	462.21
January 2011	112	215.40	138	255.80	250	471.20
April	70	153.64	142	288.20	212	441.84
July	201	371.49	118	268.57	319	640.06
October	140	314.26	72	203.59	212	517.85
January, 2012	112	256.76	138	297.18	250	553.94

Table 2.5: Quantum of Food Subsidies Released by Government Of India

Year	Food Subsidy (Rs. crore)	GDP (Rs. Crore)	% of GDP	Annual Growth (%)
2004-05	25,746.45	2,971,464	0.87	2.33
2005-06	23,071.00	3,253,073	0.71	-10.39
2006-07	23,827.59	3,564,364	0.67	3.28
2007-08	31,259.68	3,896,636	0.80	31.19
2008-09	43,668.08	4,158,676	1.05	39.69
2009-10	58,242.45	4,516,071	1.29	33.38
2010-11	62,929.56	4,918,533	1.28	8.05

Source: Department of Food and Public Distribution. World Bank. A lakh equals 100,000. A crore equals ten million.

Table 2.6: Process for identification of BPL families

Authority	Role	Details [26]
NSSO	Conducts sample survey of consumer expenditure every five years.	Consumer expenditure is the expenditure of a household on some basic goods and services. The expenditure on this basket of goods is the basis for the poverty line.
Planning Commission	Estimates state-wise poverty, i.e., the number of people below the poverty line.	Uses NSSO household expenditure data.
Central Government	Allocates food grains to each state based on state-wise poverty estimates of Planning Commission and population projections of the Registrar General of India as of March 2000.	The number of BPL families has been calculated using 1993-94 poverty estimates by Planning Commission. This number has not been revised despite the release of new poverty estimates by the Planning Commission in 2004-05 and 2011-12.
Ministry of Rural Development	Comes out with criteria for inclusion and exclusion from BPL list as part of its BPL Census.	Criteria for classification of BPL families, as per BPL Census 2002, include parameters like size of land holding, clothing owned, food security, means of livelihood etc.
State Governments	Identify eligible households.	Based on above criteria.

[26] *Sources: Department of Food and Public Distribution; Planning Commission; Ministry of Rural Development; PRS. (Rajendran & Reddy 2015)*

Table 2.7: Statewise PDS characteristics

Generosity of PDS [27]						
Criteria		TN	AP	KL	KA	MH
I. Intensive Margin (Entitlements)	Max Qty per card (Rice & Wheat, kgs.)	30	30	32	23	35
	PDS Price of Rice(Rs.)	Free	1	1	3	6
	Subsidy on Rice (using CIP of GOI, Rs./kg.)	5.65	4.65	4.65	2.65	-0.35
	Subsidy on Rice (using retail prices, Rs./kg.)	24	21	31	19	19
II. Extensive Margin (Exclusion Norms)	Income per annum (> Rs.)	None	Urban 75,000 Rural 65,000	21,000	Urban 17,000 Rural 12,000	15,000
	Land (> acres)	None	2.5 wet 5 dry	1 (excluding STs)	3	2.9 rain fed 2.5 semi-irrigated 1.2 irrigated
	Income tax payers	None	None	None	Exclude	Exclude
	Government Employees	None	Exclude ones with permanent positions	Exclude	Exclude	Exclude doctors, advocates, architects and chartered accountants
	Four wheelers owned	None	Exclude (other than provided under govt. schemes)	Exclude	Exclude	Exclude
	Residential telephone owned	None	None	None	Exclude	Exclude
III. Implementation	% of population with access to PDS (All India : 50.03)	94.68	89.26	85.02	76.06	48.12
	% with BPL ration cards (All India: 37.92)	87.81	85.07	28.76	62.99	27.07
	% Diversion of PDS grain (All India : 43.9)	4.4	19.2	16.2	41	42.5
	% HHs consuming rice from PDS (All India : 45.81)	89.65	86.36	79.64	75.02	44.22
	Implicit Income Transfer (Rs.) per HH per month (All India: 85.21)	218.25	121.56	129.18	104.38	60.16

[27] *Sources: Reports of Justice Wadhwa Committee on Public Distribution System, State Food and Civil Supplies portals, Khera 2011, Masiero 2012, Rahman 2014*

Table 2.8: Statewise Summary Statistics

Variable	TN	AP	KL	KA	MH
Vulnerability	0.163	0.143	0.118	0.153	0.237
Wealth	0.886	-0.431	2.018	-0.742	-0.334
Malnutrition	0.952	0.953	0.894	0.957	0.931
Consumption per capita (Rs)	2,467	2,750	3,098	2,515	2,042
Households	1,982	2,203	1,570	3,865	3,309
Years in Place	70	76	71	81	73
Income (Rs. lakh)	1.245	0.858	1.744	1.223	1.335
Population density (per km^2)	555	308	859	319	365
Net Domestic Product Per Capita (Rs.)	89,050	64,773	82,753	68,053	93,281
% land under rice cultivation	13.32	10.68	4.73	4.81	1.28
PDS Subsidy (Rs.) per household	426.990	339.064	204.174	205.877	39.603
Distance (kms)	80.105	102.723	32.730	73.791	268.496

Table 2.9: Sub Groups Summary Statistics

Variable	SC/ST	OBC	All
Vulnerability	0.205	0.155	0.168
Wealth	-1.375	0.256	0.000
Malnutrition	0.943	0.944	0.941
Consumption per capita (Rs)	1,890	2,572	2,497
Households	3,288	6,490	12,929
Income (Rs. lakh)	0.988	1.227	1.256
BPL ration card holders (%)	75.24	63.45	59.72

Table 2.10: Generosity of PDS impacts: Vulnerability

Specification	Full Sample	SC/ST	OBC
	(1)	(2)	(3)
(a)Polynomial degree 1 (linear model)			
τ_{IK}	-0.056***	-0.079	-0.054***
	(0.018)	(0.051)	(0.020)
τ_{CCT}	-0.069***	-0.076	-0.054***
	(0.019)	(0.051)	(0.020)
(b)Polynomial degree 2 (quadratic model)			
τ_{IK}	-0.078***	-0.115*	-0.065***
	(0.019)	(0.062)	(0.022)
τ_{CCT}	-0.085***	-0.117*	-0.081***
	(0.020)	(0.062)	(0.022)
(c)Polynomial degree 3 (cubic model)			
τ_{IK}	-0.102***	-0.126*	-0.056**
	(0.028)	(0.067)	(0.025)
τ_{CCT}	-0.085***	-0.162**	-0.098***
	(0.022)	(0.074)	(0.025)

Note: Estimates using a triangular kernel. Subscripts *IK* and *CCT* denote bandwidth choices according to Imbens and Kalyanaraman (2012) and Calonico et al.(2014) respectively. Standard errors are reported in parentheses. ***,**,* indicates significance at the 1%, 5%, 10%-level, respectively.

Table 2.11: Generosity of PDS impacts: Vulnerability Across Occupational Groups

Occupational Group	Mean	Urban %	τ_{IK}	τ_{CCT}
	(1)	(2)	(3)	(4)
Ag wage lab (landless)	0.225	12	-0.031	-0.010
	(0.134)		(0.096)	(0.103)
Construction workers (landless)	0.208	46	-0.373*	-0.373*
	(0.135)		(0.194)	(0.194)
Construction workers	0.203	33	-0.276**	-0.178*
	(0.134)		(0.117)	(0.093)
Other	0.201	72	-0.128	-0.058
	(0.145)		(0.402)	(0.129)
Non ag wage lab (landless)	0.200	62	-0.143***	-0.121**
	(0.132)		(0.049)	(0.053)
Automobile Drivers	0.188	56	-0.234**	-0.261**
	(0.134)		(0.107)	(0.106)
Unemployed	0.171	41	-0.028	-0.055
	(0.137)		(0.057)	(0.063)

Note: Category 'Other' includes shoemakers, maids, carpenters & caretakers. Estimates using a triangular kernel and a functional specification of polynomial degree 2. Subscripts *IK* and *CCT* denote bandwidth choices according to Imbens and Kalyanaraman (2012) and Calonico et al.(2014) respectively. Standard errors are reported in parentheses. ***,**,* indicates significance at the 1%, 5%, 10%-level, respectively.

Table 2.12: Generosity of PDS impacts: Vulnerability Across Poverty Thresholds

	Threshold 1	Threshold 2	Threshold 3	Threshold 4
	(1)	(2)	(3)	(4)
Full Sample	-0.176**	-0.113***	-0.151*	-0.093
	(0.068)	(0.044)	(0.086)	(0.069)
SC/ST/OBC	-0.185**	-0.139***	-0.157*	-0.231**
	(0.078)	(0.050)	(0.090)	(0.113)

Note: Thresholds are as follows - Threshold 1: 17,235 < income < 27,235; Threshold 2: 27,235 < income < 37,235; Threshold 3: 7000 < income < 12,000; Threshold 4: 12,000 < income < 17,000. Estimates using a triangular kernel and a functional specification of polynomial degree 2. Bandwidth choices according to Calonico et al.(2014). Standard errors are reported in parentheses. ***,**,* indicates significance at the 1%, 5%, 10%-level, respectively.

Table 2.13: Generosity of PDS impacts on Vulnerability: Channels

	Consumption	Savings	Wealth	Investment	Livestock	Labor Supply	Casual Jobs
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Full Sample	-0.038	0.293	2.090***	0.199***	2.686***	0.668***	-0.365***
	(0.077)	(0.194)	(0.393)	(0.056)	(0.969)	(0.129)	(0.137)
SC/ST	-0.037	0.441	1.161**	0.213***	4.337*	0.509**	-0.471**
	(0.100)	(0.320)	(0.559)	(0.077)	(2.503)	(0.229)	(0.233)
OBC	-0.060	0.282	2.416***	0.140**	1.654*	0.676***	-0.322**
	(0.100)	(0.247)	(0.557)	(0.069)	(0.914)	(0.161)	(0.156)

Note: Estimates using a triangular kernel and a functional specification of polynomial degree 2. Bandwidth choices according to Calonico et al.(2014). Standard errors are reported in parentheses. ***,**,* indicates significance at the 1%, 5%, 10%-level, respectively.

Table 2.14: Generosity of PDS impacts on Vulnerability: Sources

Source	Full Sample	SC/ST	OBC
	(1)	(2)	(3)
(a)Intensive Margin	-0.047 (0.005)	-0.050 (0.008)	-0.031 (0.007)
(b) Extensive Margin 1	-0.085 (0.007)	-0.093 (0.014)	-0.068 (0.010)
(c) Extensive Margin 2	-0.026 (0.004)	-0.026 (0.010)	-0.018 (0.006)

Note: ATT estimates using propensity score matching with Caliper 0.005. All impacts are significant at the 1% level. *Intensive Margin* is higher utilization, *Extensive Margin 1* is lower Type I errors and *Extensive Margin 2* is higher eligibility.

Table 2.15: Generosity of PDS impacts: Malnutrition

Specification	Full Sample	SC/ST	OBC
	(1)	(2)	(3)
(a)Polynomial degree 1 (linear model)			
τ_{IK}	-0.015	-0.059	-0.013
	(0.033)	(0.095)	(0.038)
τ_{CCT}	-0.016	-0.047	-0.014
	(0.032)	(0.107)	(0.036)
(b)Polynomial degree 2 (quadratic model)			
τ_{IK}	-0.023	-0.003	-0.031
	(0.039)	(0.125)	(0.047)
τ_{CCT}	-0.026	-0.040	-0.033
	(0.039)	(0.119)	(0.046)
(c)Polynomial degree 3 (cubic model)			
τ_{IK}	-0.014	0.020	-0.017
	(0.045)	(0.140)	(0.053)
τ_{CCT}	-0.025	0.018	-0.043
	(0.046)	(0.145)	(0.050)

Note: Estimates using a triangular kernel. Subscripts *IK* and *CCT* denote bandwidth choices according to Imbens and Kalyanaraman (2012) and Calonico et al.(2014) respectively. Standard errors are reported in parentheses. ***,**,* indicates significance at the 1%, 5%, 10%-level, respectively.

Table 2.16: Generosity of PDS impacts: Vulnerability (Robustness)

	Dell	Dell Modified	Diff-in-Diff 1	Diff-in-Diff 2
	(1)	(2)	(3)	(4)
genrs	**-0.042*****		0.018*	-0.004
	(0.012)		(0.010)	(0.011)
pbpl		**-0.088*****		
		(0.023)		
polydist	0.000***	0.000***		0.000***
	(0.000)	(0.000)		(0.000)
cutoff			0.128***	0.121***
			(0.007)	(0.008)
cutoff*genrs			**-0.045*****	**-0.035*****
			(0.009)	(0.010)
constant	-0.061	0.014	0.088***	-0.103*
	(0.063)	(0.065)	(0.008)	(0.055)
R^2	0.030	0.038	0.162	0.177

Note: 'genrs' is a dummy variable indicating whether a district is located on the more generous PDS side of the boundary. *'pbpl'* is the proportion of households with a BPL ration card. *'polydist'* is the polynomial in latitude and longitude. *'cutoff'* is a dummy variable for whether household per capita consumption is less than Rs. 27,235. In specification 2 (Dell Modified), *'pbpl'* is instrumented with *'genrs'*. Figures in bold give the relevant impact estimates. Robust clustered (at district level) standard errors are reported in parentheses. ***,**,* indicates significance at the 1%, 5%, 10%-level, respectively.

Table 2.17: Generosity of PDS impacts: Vulnerability (Bootstrapped Standard Errors)

Sample	τ_{IK} (1)	τ_{CCT} (2)
Full Sample	-0.078***	-0.085***
	(0.018)	(0.020)
SC/ST	-0.115**	-0.117
	(0.057)	(0.078)
OBC	-0.065***	-0.081***
	(0.021)	(0.024)

Note: Estimates using a triangular kernel and a functional specification of polynomial degree 2. Subscripts *IK* and *CCT* denote bandwidth choices according to Imbens and Kalyanaraman (2012) and Calonico et al.(2014) respectively. Bootstrapped standard errors are reported in parentheses. ***,**,* indicates significance at the 1%, 5%, 10%-level, respectively.

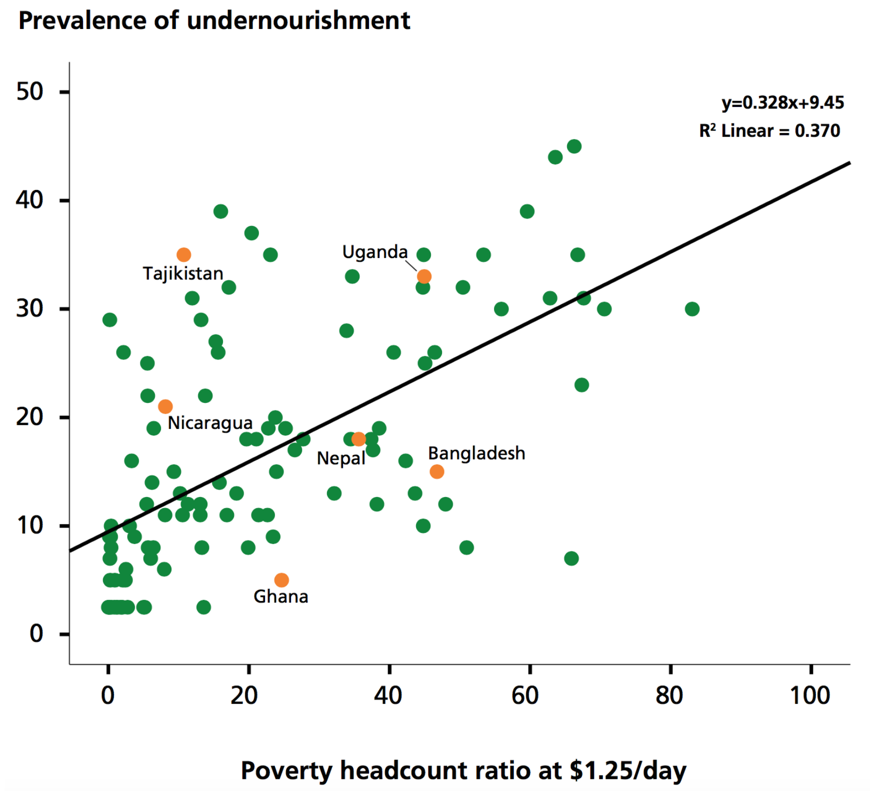
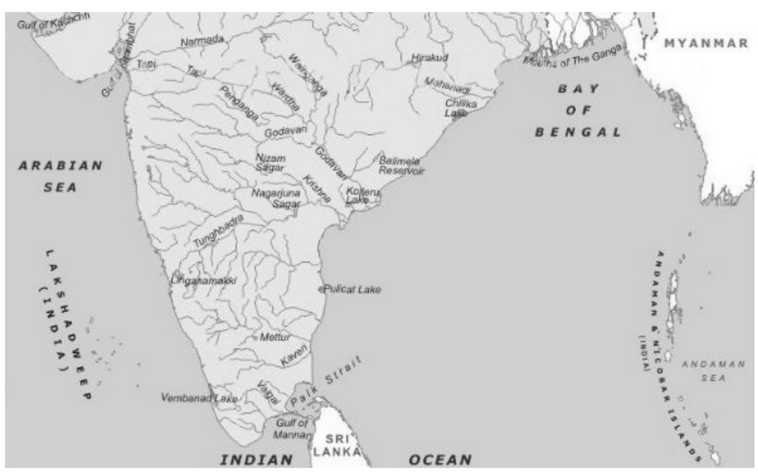


Figure 2.1: Correlation of Poverty and Undernourishment At the Country Level

Source: FAO (2013).

Note: Undernourishment is 'a state, lasting for at least one year, of inability to acquire enough food, defined as a level of food intake insufficient to meet dietary energy requirements'. In the FAO report 'hunger' is synonymous with 'chronic undernourishment'.

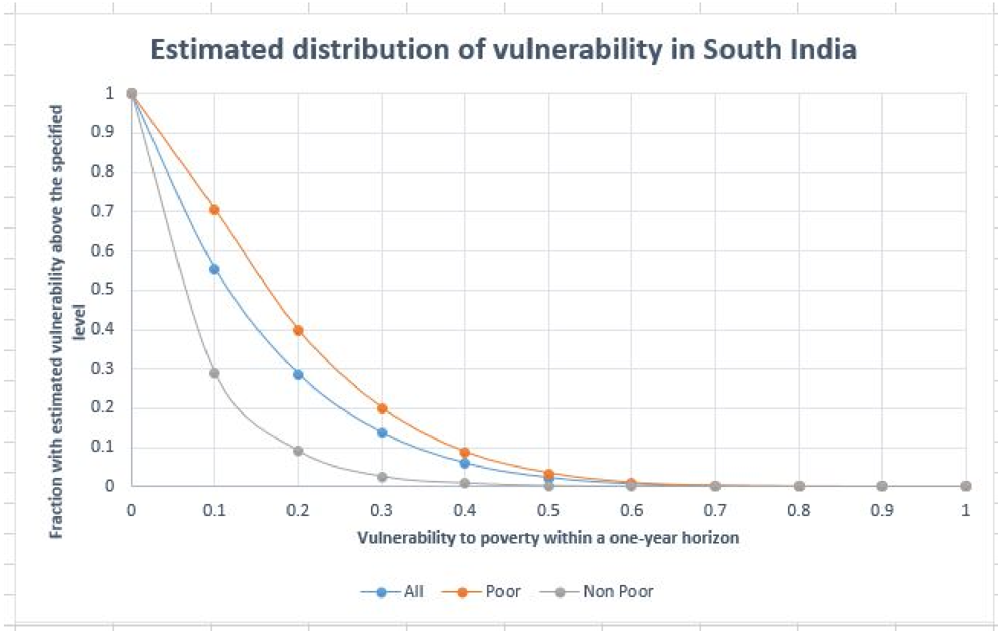
(a) The quasi-experimental border



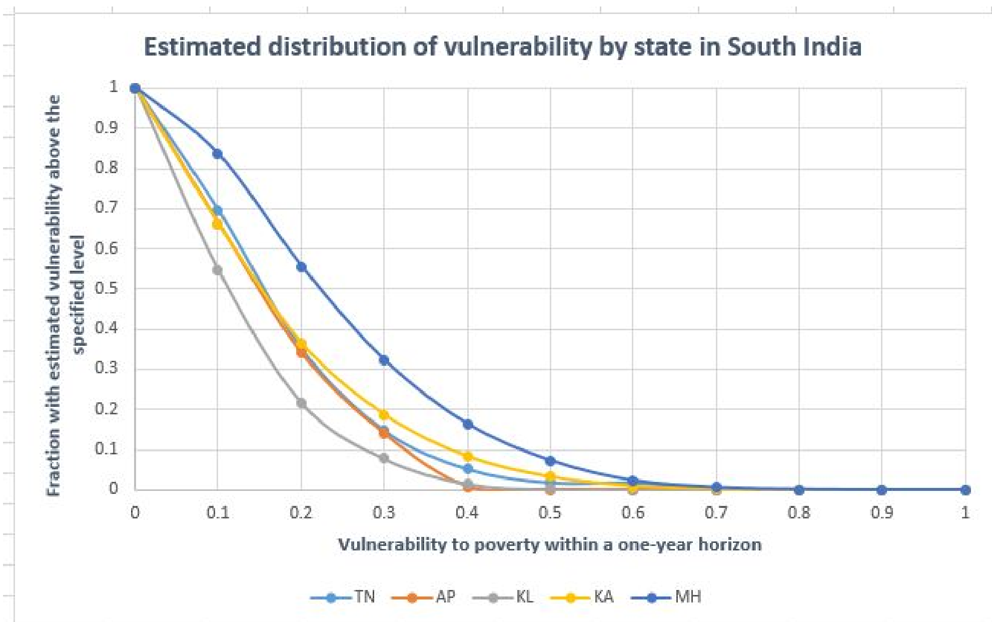
(b) Rivers of Peninsular India

Figure 2.2: South India

Source of 2.2(b): www.tutorialspoint.com



(a)



(b)

Figure 2.3: Distribution of Vulnerability

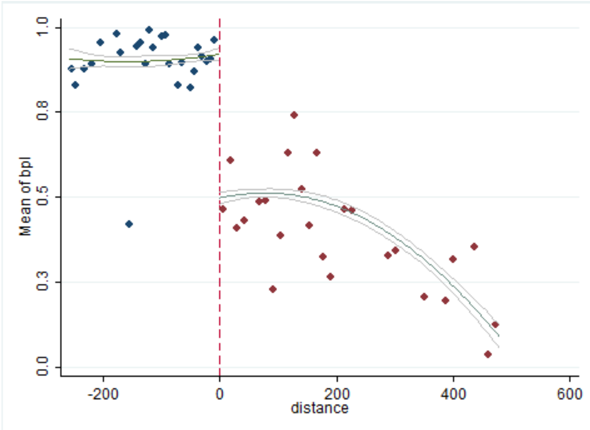


Figure 2.4: BPL ration card holders

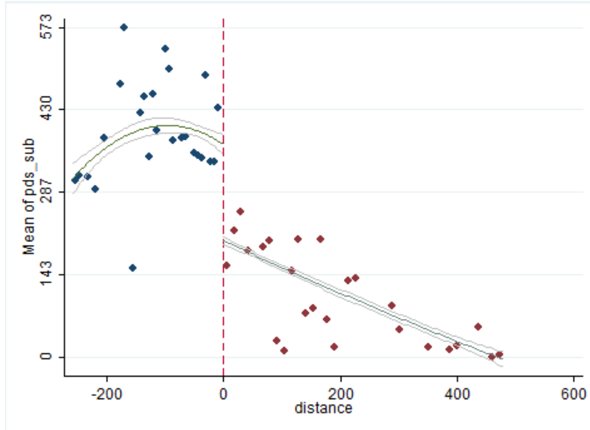


Figure 2.5: PDS Subsidy

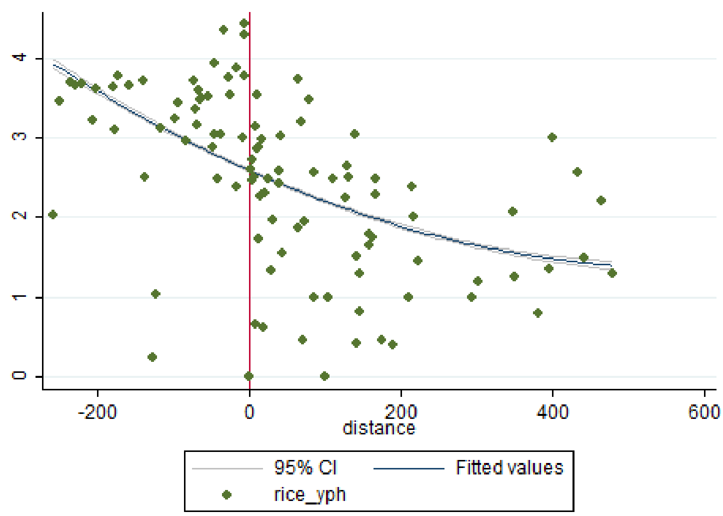
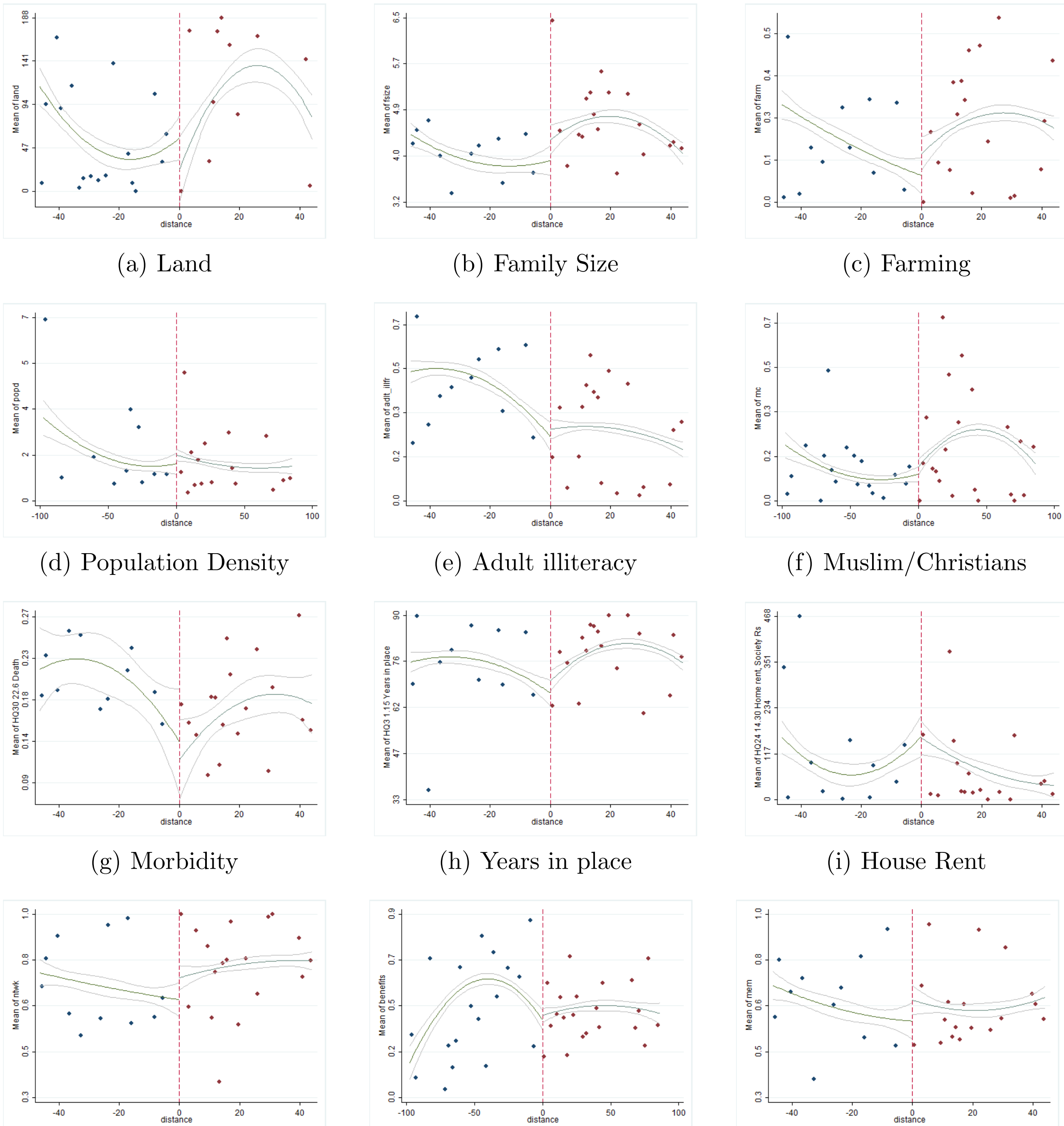


Figure 2.6: Correlation of distance with rice production

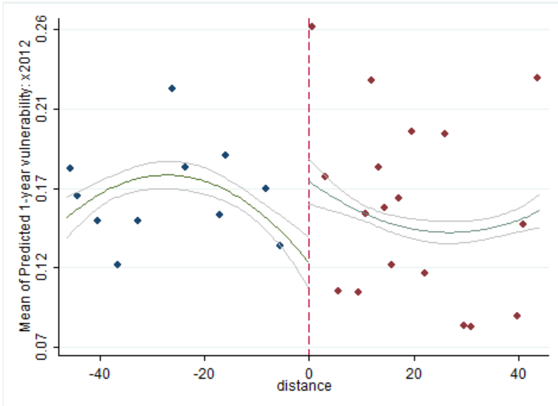
Note: Districts with a negative [positive] distance are located on the more [less] generous side of a border.



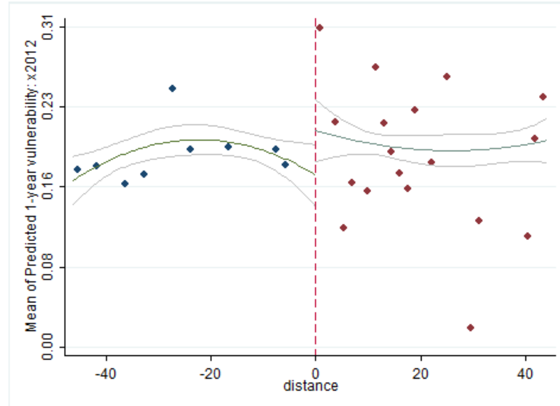
(a) Land
(b) Family Size
(c) Farming
(d) Population Density
(e) Adult illiteracy
(f) Muslim/Christians
(g) Morbidity
(h) Years in place
(i) House Rent
(j) Networks
(k) Benefits
(l) Memberships

Figure 2.7: Distribution of household characteristics

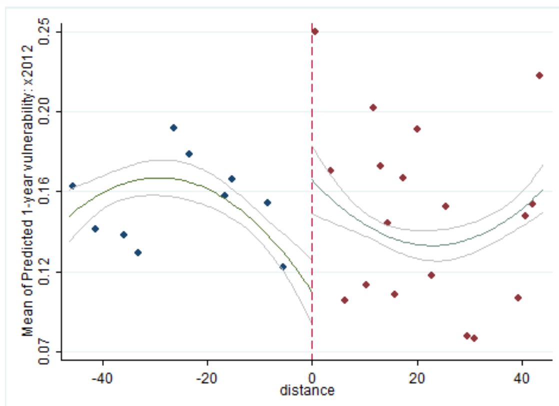
Note: The figure illustrates the distribution of several key variables among households in districts within a 50-100 km distance to the closest state border in the main sample. Districts with a negative [positive] distance are located on the more [less] generous side of a border.



(a) Full Sample



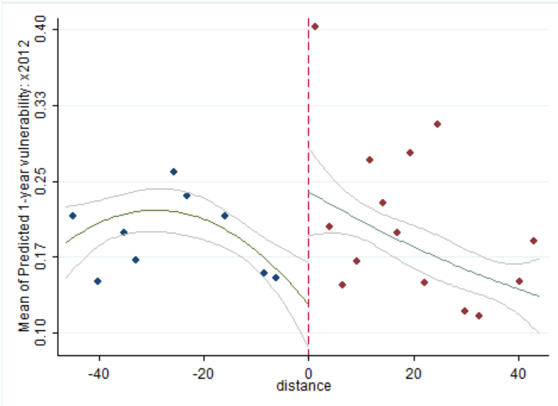
(b) SC/ST



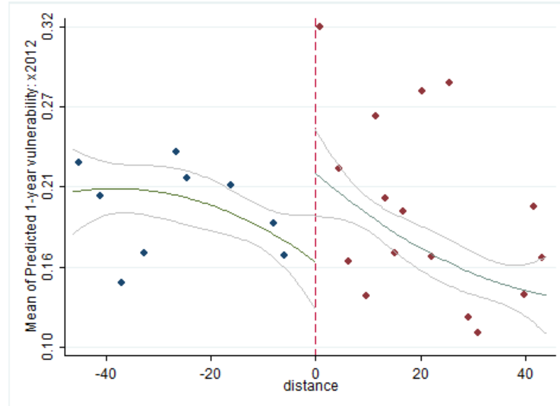
(c) OBC

Figure 2.8: Generosity of PDS Impacts: Vulnerability

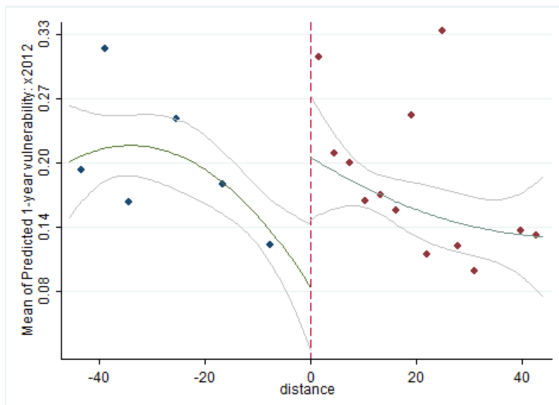
Note: Districts with a negative [positive] distance are located on the more [less] generous side of a border.



(a) Construction Workers (landless)



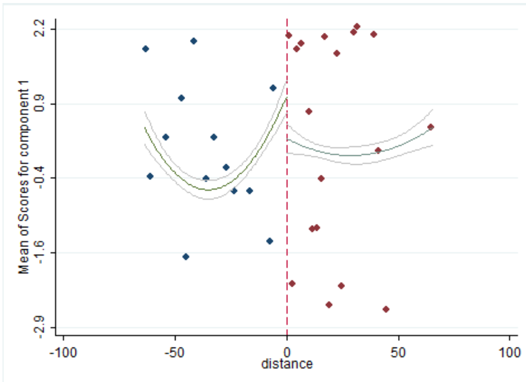
(b) Non ag wage lab (landless)



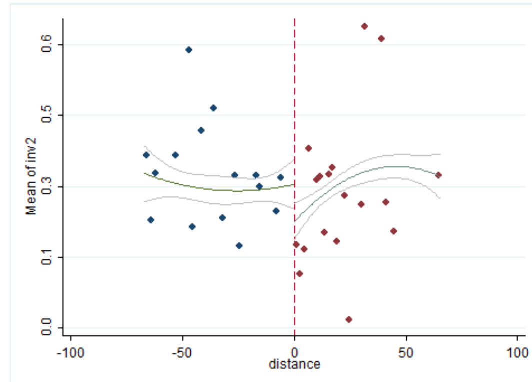
(c) Automobile Drivers

Figure 2.9: Generosity of PDS Impacts: Vulnerability Across Occupational Groups

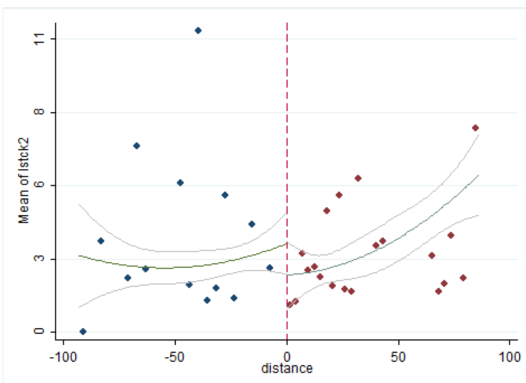
Note: Districts with a negative [positive] distance are located on the more [less] generous side of a border.



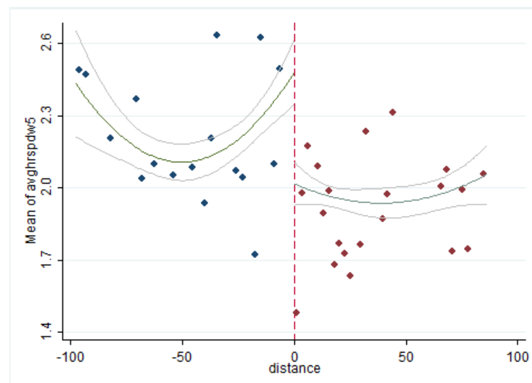
(a) Wealth



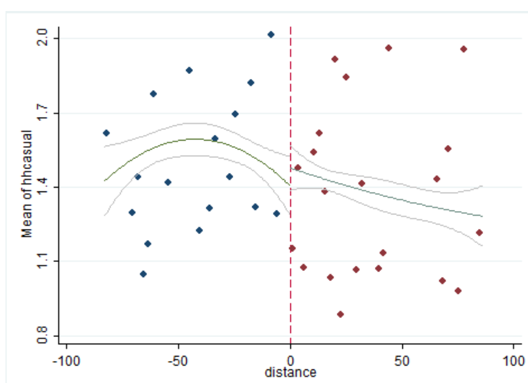
(b) Investment



(c) Livestock



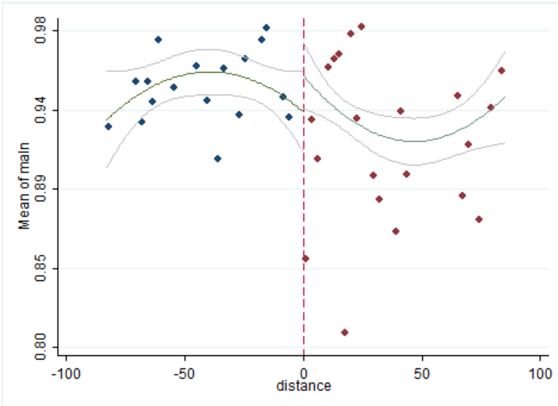
(d) Labor Supply



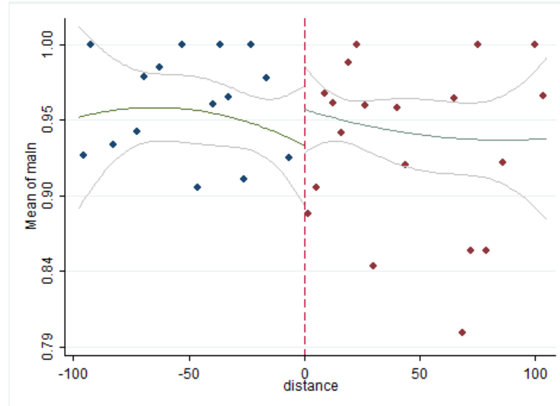
(e) Casual Jobs

Figure 2.10: Channels (Full Sample)

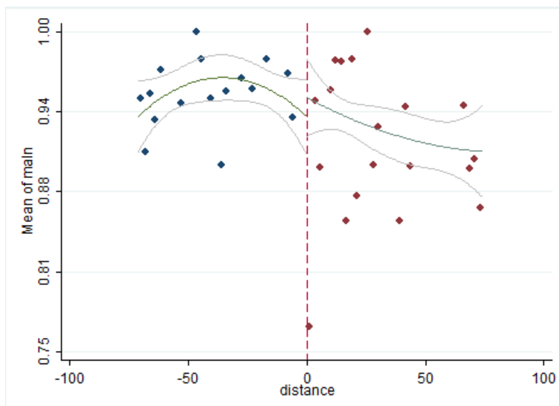
Note: Districts with a negative [positive] distance are located on the more [less] generous side of a border.



(a) Full Sample



(b) SC/ST



(c) OBC

Figure 2.11: Generosity of PDS Impacts: Malnutrition

Note: Districts with a negative [positive] distance are located on the more [less] generous side of a border.

Chapter 3

Cash *and* Food? Tackling Poverty with Conditional Transfers

3.1 Introduction

A significant amount of redistribution through social welfare programs in the developing world takes place in-kind, even though governments are increasingly investing in cash transfer programs. Globally, about 92% of low-income countries have in-kind transfer programs, whereas only 51% have a cash transfer program (Gentilini et al. 2014). Cash transfers have some major advantages of having lower transaction costs and being possibly easier to monitor. While certain design issues are common to all social transfer interventions (including who should receive benefits, how much should be given), the welfare impacts on the beneficiaries depend critically on how the transfers are utilized by them. Economic theory predicts that a program recipient will at least weakly prefer a cash transfer as compared with an equal-valued in-kind transfer as it gives them more choices. However, if beneficiaries end up spending the cash indiscriminately on temptation goods, then the long term program objectives of improving living standards may not be realized.

The debate over the relative merits of cash as compared with in-kind transfers as a form of food security has a long history in economics. Economic theory apart, there are several reasons why in-kind transfers might be preferred to cash (Aker 2015). First, there is the "paternalistic" argument that governmental or non-governmental organizations might be able to guide program recipients to purchase and consume particular food or non-food items through in-kind transfers which could result in better outcomes for them. Second, in-kind transfers may facilitate "self-targeting" among rich and poor recipients resulting in a more efficient transfer system. Third, in-kind distributions can increase the local supply of items that are not readily available on local markets and act as a check on inflation. Lastly, assuming cash is easier to steal, providing in-kind transfers could be less risky for program recipients.

How should wealth be redistributed to the poor? This is the question addressed in this paper through an analysis of the Productive Safety Net Programme (PSNP) in Ethiopia. Ethiopia's PSNP is an international flagship program both in its scope and in its partnership approach. It serves as an example of a large-scale social safety net that reaches a large number of dispersed, low-income rural residents with diverse livelihoods and creates productive investments to underpin rural economic growth and environmental rehabilitation. In 2009, the PSNP supported 7.6 million people in 290 chronically food insecure woredas in 8 of the country's 10 regions. This is equivalent to roughly 10% of the national population, covering over 40% of the country's woredas. The annual budget in 2009 was approximately $360 million or about 1.2% of Ethiopia's GDP (Coll-Black et al 2009). The combination of cash and food transfers that is provided under the program creates an ideal natural experimental setting for evaluation of the two types of transfers. Specifically, I examine the impacts of a cash versus equal valued in-kind conditional transfer on vulnerability to poverty of the population eligible for PSNP in Ethiopia using a geographic polynomial regression.

My empirical results corroborate economic theory. They indicate that a household's ability to mitigate risk and cope with shocks is enhanced with a cash transfer as compared to an equal valued in-kind transfer. A cash transfer reduces overall household vulnerability to poverty by around 12% for a sample of households eligible for public work under PSNP. The impacts are largest for households engaged in agriculture and allied activities, which is the most vulnerable group in the sample. However, households receiving the cash transfer do spend marginally more on temptation items, like alcohol and cigarettes. I also find a positive but small impact of cash versus in-kind transfer on the average price. Thus, a combination of cash and food transfers under the same program framework seems to hold considerable potential: a rightly-calibrated mix of transfers could help protect households from high and volatile food prices.

My paper adds to a small but growing literature on cash versus in-kind transfers in the context of food security. There is extensive literature on the impacts of in-kind and cash transfers separately (Whitmore 2002; Hoynes and Schazenbach 2009; Fraker et al. 1995; Yen 2010). But the empirical evidence of their relative impacts is more limited and there is mixed evidence. In a randomized evaluation study in Burkina Faso, Akresh et al (2016) et al find that conditional cash transfers outperform unconditional cash transfers. Hence, in my paper I concentrate on a comparison of a conditional (public works) cash transfer versus in-kind transfer rather than unconditional transfers. The comparison between cash and food transfers has been all the more challenging due to differences in program design between the two modalities (Cunha 2014, Skoufias et al. 2008, Gentilini 2014, Sivakul 2012), which I eliminate by concentrating on PSNP. There have been a couple of randomized controlled trials testing this question where the conditions of obtaining the transfer were as similar as possible under the two modalities (Aker 2015, Hidrobo et al 2014). However, the PSNP is a very large program affecting millions of people in the context of a large developing country, and hence the results in this paper have greater external validity. My paper also contributes to the active literature in two respects - choice of outcome variable and the method, which haven't been done before. My paper is also one of the few to test for price effects under a cash transfer program which Cunha et al (2011) find evidence for.

The rest of the paper is organized as follows. Section 2 gives the background of the PSNP, section 3 gives the economic theory and describes my measure of poverty, section 4 describes the data and identification strategy, section 5 provides a summary of the results and robustness checks, and finally, section 6 concludes.

3.2 Background

For more than a decade, between 1993 and 2004, the Government of Ethiopia followed a system where they annually identified the depth of food shortages in traditionally vulnerable areas and made emergency appeals for international food aid and other forms of assistance. Though this system succeeded in preventing mass starvation, it was not efficient and failed to avert famines or asset depletion among the food-insecure population (Jayne et al 2002).

Starting in 2005, the government and a consortium of donors implemented a large-scale social safety net programme called the Food Security Programme (FSP), which was targeted initially at the 282 most chronically food-insecure woredas in rural Ethiopia. The Productive Safety Net Programme (PSNP) was the flagship program of the FSP, established with the aim to provide predictable and reliable transfers (cash or food) to the food-insecure population in chronically food-insecure woredas, in a way that prevents asset depletion at the household level and creates assets at the community level (Berhane et al 2016). Under the program, poor and food insecure households that have able bodied adult labour engage in public works and receive transfers for 6 months of the year. Households without labour capacity, like those whose primary income earners are elderly or disabled, qualify for direct support and receive 12 months of unconditional transfers.

The balance between cash and food transfers is finalised at the central level. Regions and woredas are informed in writing each season what the arrangements will be for that year. The PSNP has a cash-first principle. Cash is the preferred mode of transfer in areas which: are near food surplus areas (in the same or a neighboring woreda), have active food markets, and have cash management capacity (presence of finance officers, cashiers, safes, transport, security at woreda level). Food is chosen as a mode of payment when: food markets function poorly and availability of food and prices are unpredictable, price of food in markets are so high as to make cash transfers the higher cost option, and there is lack of experience in cash management and better food management capacity. The daily wage rate of the cash transfer is calculated based on the cost of buying 3 kg of cereal and 0.8 kg of pulses per day (15 kg of cereal and 4 kg of pulses per person per month) in the market. The PSNP provides a cash transfer to households that can purchase 3 kgs of the cheapest cereal and 0.8 kg of the cheapest pulses available in the market. PSNP clients receive the same transfer regardless of whether they are a permanent direct support client or a public works and links to social services client (GFDRE 2014).

3.3 Theory & Measure

3.3.1 Economic Intuition

In this section I outline the basic theory of consumer demand underlying cash and in-kind transfers, with some simplifying assumptions. Assume a household with a well behaved utility function over 2 goods, food and a composite good, representing all other goods. The household acts as a single unit and maximizes its utility with respect to a linear budget constraint ($\overline{AB}$ in Figure 3.1) .

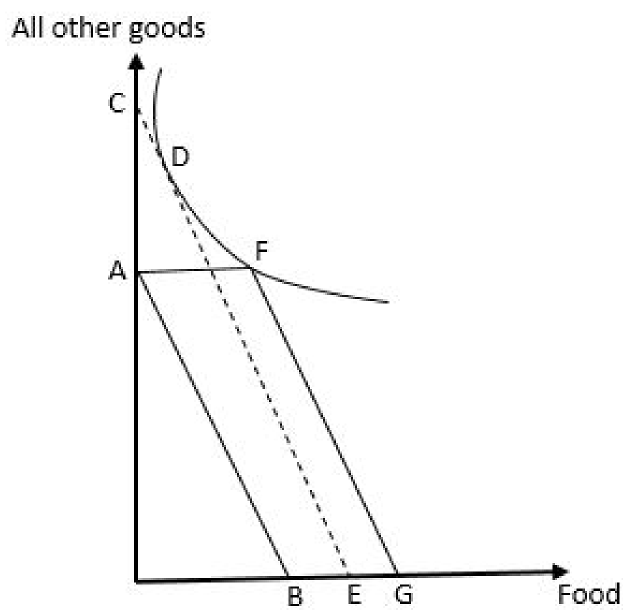


Figure 3.1: Cash versus In-kind Transfer

Now assume that the household receives an in-kind transfer which: (a) it is not allowed to resell and (b) is extra-marginal.[1] Then the budget line shifts outward to $\overline{FG}$ and the utility maximizing consumption point is given by F. As we can see, the household can achieve the same level of utility with a lower cash transfer (represented by $\overline{CE}$) by consuming at point D. This illustrates that a cash transfer is weakly superior in terms of the recipients' utility (and hence welfare) than an equal-value in-kind transfer, as it allows recipients to switch the composition of their expenditures from food to non-food more easily. However, as mentioned earlier, distorting in-kind transfers are preferred over cash transfers in a lot of cases due to paternalism and other reasons.

3.3.2 Vulnerability to poverty

Vulnerability is the prospect that an individual will fall below some norm or benchmark of welfare at a given time in the future, where the time period and welfare measure are sufficiently general. It is an ex-ante measure of a household's well-being (unlike poverty, which is an ex-post measure).[2] I refrain from using the usual measures of poverty and concentrate on a relatively broader and more dynamic measure of deprivation - vulnerability to poverty, which incorporates the destitution of individuals from future shocks. This is a more appropriate measure of relatively long term well being of households. The literature proposes three alternative approaches to assessing vulnerability (Hoddinott and Quisumbing 2003): vulnerability as expected poverty (VEP), vulnerability as low expected utility (VEU) and vulnerability as uninsured exposure to risk (VER). VEP and VEU approaches measure vulnerability at the individual level as a probability and summing up over all households

[1] For the purpose of simplification. The results remain unchanged if we relax these two assumptions (see Cunha 2014).

[2] Poverty and vulnerability, though correlated, are conceptually different as depending on whether a household has secure income sources, a household above the poverty line may be vulnerable, or one just below the poverty line may not be vulnerable. The presence of risk or uncertainty about the future distinguishes the two concepts. A household faces multiple sources of risk which makes its future uncertain, like weather shocks, health shocks, e.t.c. Without this risk, the two concepts would be identical.

gives a measure of aggregate vulnerability. VER measures do not construct probabilities, but rather assess ex post whether observed shocks generate welfare losses at the aggregate level. VEU approaches are problematic because the unit of measurement is units of utility, which many policymakers might not be familiar with and may be difficult to understand. The appropriate measure for this paper would be an ex-ante individual measure of poverty that is easy to understand. Also, a measure of vulnerability that takes account of poverty levels seems preferable. Hence, following the VEP approach in Chaudhuri et al. (2002), I define vulnerability as "the ex-ante risk that a household will, if currently non-poor, fall below the poverty line, or if currently poor, will remain in poverty."

Formally, the vulnerability level of a household h at time t is defined as the probability that the household will find itself consumption poor[3] at time t+1:

$$v_{ht} = Pr(c_{h,t+1} \leq z)$$

where $c_{h,t+1}$ is the household's per-capita consumption level at time t+1 and z is the appropriate consumption poverty line. The procedure for estimating household vulnerability follows from Chaudhuri et al. (2002) (see Appendix). The covariates to estimate v_{ht} include:

A: A set of variables indicating household characteristics, such as (i) Family size and squared (ii) Dependency ratio - child (0-14), teen (15-20) and old (60+) (iii) Proportion of adults (21-60) (iv) Age of head and squared (v) Proportion of adults illiterate (vi) Proportion of adults with primary education (vii) Proportion of adults with secondary education (viii) Proportion of adults with some higher education (ix) Dummy for male head, whether head is married, single or separated (x) Per capita land area owned and squared (xi) Dummy for whether household has access to a flush toilet, tap water in all seasons, electricity

[3]According to the World Bank (2000), "poverty is pronounced deprivation in wellbeing." The main focus here is on whether households have enough resources to meet their consumption needs. Poverty is then measured by comparing households' consumption with some defined threshold below which they are considered to be poor. Poverty is largely seen in monetary terms, via consumption expenditure.

B: A set of variables indicating community characteristics (at enumeration area level), such as (i) road condition (ii) distance to nearest - bus station, woreda / town, urban center, weekly market, phone, government primary school, government secondary school, private primary schools, private secondary schools, shop for common medicines, health post, hospital, commercial bank, microfinance institution (iii) electricity at - government primary school, government secondary school, health post (iv) Availability of nurse / doctor at health post and hospital (v) presence of social welfare programs - programs providing bed nets, programs providing support for chronically ill (vi) water service.

An advantage of this vulnerability measure is that it can be estimated with cross-sectional data and the possibility of poverty traps and other non-linear dynamics are implicitly built in. However, it assumes that the distribution of consumption across households, given the household characteristics at time t, represents time-series variation of household consumption. Thus, a large sample is required for this measure in which some households experience positive shocks and others negative shocks. It also assumes economic stability and does not incorporate the possibility of aggregate shocks.

3.4 Data & Identification Strategy

3.4.1 Data

The analysis uses the Ethiopia Socioeconomic Survey (ESS) wave two data (2013/2014), which was collected between September 2013 and April 2014. The ESS is a collaborative project between the Central Statistics Agency of Ethiopia (CSA) and the World Bank Living Standards Measurement Study - Integrated Surveys of Agriculture (LSMS-ISA) project. Ethiopia is one of seven countries being supported by the World Bank, through funding from the Bill and Melinda Gates Foundation (BMGF), to strengthen the production of household-level data on agriculture. ESS began as ERSS (Ethiopia Rural Socioeconomic Survey) in 2011/12. The first wave of data collection in 2011/12 included only rural and small town areas. The survey name dropped the word "Rural" in the second wave of data collection when the sample was expanded to include all urban areas. The urban supplement was done in such a way to ensure that the ESS wave 2 data can provide nationally representative estimates.

The ERSS/ESS sample is a two-stage probability sample. The first stage of sampling entailed selecting enumeration areas (ie. the primary sampling units) using simple random sampling (SRS) from the sample of the AgSS enumeration areas (EAs). The AgSS EAs were selected based on probability proportional to size of population (PPS). For the rural sample, 290 EAs were selected from the AgSS EAs. For small town EAs, a total of 43 EAs were selected by PPS. Similarly, for the newly added urban areas, a total of 100 EAs were selected (PPS). The sample for the ERSS (Wave 1) comprises 4,000 households in rural and small towns areas across Ethiopia. The sample for ESS (Wave 2) was expanded to include 1,500 urban households, for a total sample of 5,500 households.

The objective of the LSMS-ISA is to collect multi-topic panel household level data with a special focus on improving agricultural statistics and the link between agriculture and other household income activities. The ESS data files also include additional geospatial data computed for data users. There is also information on market prices, which was collected around 2006. Hence, I use inflation rates from the World Bank to predict prices in 2013 (for estimating payment type) and 2016 (for checking price effects).

3.4.2 Sample Construction

The simplest way of assessing the impact of the cash versus in-kind conditional transfers would be to compare mean outcomes for households that receive cash salaries versus those that receive in-kind salaries. So, for example, we could calculate the mean vulnerability for cash payment workers and that for in-kind payment workers. The problem, however, with this approach is that households that receive payments in cash for work could be systematically different from those that receive payments in kind for many reasons (like income) and these also affect vulnerability, leading to biased impact estimates. Hence I restrict my sample to only households eligible for PSNP, which gives me a valid in-kind transfer recipients counterfactual group to cash transfer beneficiaries.[4] I could then compare the mean vulnerability for cash beneficiaries and that for in-kind beneficiaries.

The data bulks in-kind and cash payments together and does not distinguish between the two. Hence I use a proxy to identify households which receive salary in-kind versus cash for PSNP work. Households are classified as receiving salary in cash if they can afford to purchase 3 kgs of the cheapest cereal and 0.8 kg of the cheapest pulses available in the market (i.e., if their consumption expenditure in a day exceeds the cost of buying this bundle), and food otherwise. This implies that the same woreda would have recipients of both types of transfers, rather than being restricted to just one type of transfer. This procedure makes the two groups more comparable.

I identify households eligible for the public works component of PSNP in two ways. In the first method, I use a probit model to predict program participation based on Berhane et al (2016) targeting criteria. These are: household livestock holdings 12 months prior to the survey, household land holdings, age, sex and grade attainment of household head, number of males aged 1660 resident in the household and number of females aged 1660 resident in the household. I categorize a household as participating if the probability score is greater than the average. This gives me a sample of 2466 households (Sample 1). In the second method, I categorize a household as eligible for PSNP based on the targeting criteria that the household has been food insecure for 8% of the time (that is, 1 month in a year). This gives me a sample of 977 households (Sample 2).

[4] An alternative to using potential beneficiaries of PSNP would be to use actual PSNP public works participants. However, in the data, the take up rate is only 7%, leading to a sample size of only 361 households, which gives me low power to detect effects. Hence I use the actual PSNP participants as a robustness check instead.

I check the prediction success rates[5] for Samples 1 and 2, and these are 71% and 25% respectively. Thus, as Sample 1 is more successful in predicting actual PSNP participation, I focus primarily on this sample in my results section.

3.4.3 Empirical Specification

The benchmark regression model takes the form:[6]

$$y_{ij} = \alpha + \gamma cash_{ij} + \beta X_j + \text{f(geographic location}_{ij}) + \epsilon_{ij} \tag{3.1}$$

where the subscripts refer to household i in enumeration area j, y is an outcome variable of interest, *cash* is an indicator variable for whether a household receives a cash transfer (so takes a value of 1 if the household receives a cash transfer and 0 if the household receives an in-kind transfer), X is a a vector of covariates that includes mean temperature, precipitation, elevation, potential wetness index, nutrient availability, nutrient retention capacity, rooting conditions, oxygen available to roots, excess salts, toxicity and workability (constraining field management), *f(geographic location)* is a polynomial which controls for smooth functions of geographic location. I consider cubic polynomials in household latitude and longitude and also, Euclidean distance of household to the capital, Addis Ababa (as an indicator of remoteness). The coefficient of interest is γ, the intent-to-treat effect of the conditional cash transfer (as compared with an equal valued in-kind transfer).

As I am using precise coordinates for each household, the geographical polynomial assists in controlling for observed and unobserved heterogeneity when this heterogeneity is constant over time (but correlated with independent variables). The polynomial is picking up systematic differences in individual characteristics that are related to distances from markets / the capital. Households that live further away from a market could be systematically different from those that live closer, so the geographic controls flexibly control for distance. Also, it

[5]Proportion of actual PSNP participants who are also predicted as eligible for PSNP
[6]The empirical specification is similar to that of Dell (2010)

is unlikely that household level vulnerability would affect payment type, since whether a household receives a cash payment is determined by price levels in a woreda, which is not within the household's control. Hence we can say that the independent variable, *cash*, is exogenously determined and simultaneity is not a concern.

3.4.4 Summary Statistics

Table 3.1 gives the descriptive statistics for 3 groups and the full sample. The first two are the PSNP eligible households as described in section 3.4.2, and the third are the actual PSNP public works participants. The mean vulnerability for all households (PSNP and non PSNP) is about 60%. The highest vulnerability is for the actual PSNP participants (70%), which is to be expected. The mean vulnerability for the two PSNP eligible samples lie between these two. Average expenditure on food ranges between \$7 - 8 per week, for all samples. Average expenditure on non food items is about \$11 over a month for the full sample and about \$9 for the 2 PSNP eligible samples. What is striking is that actual PSNP participants spend less on non food items over a month, about \$6, than food in a week. This is also much lower than average non food consumption (\$11). This is perhaps an indication of the fact that the program is taken up only by very poor households, which have limited income over and above food consumption. Only a marginal 7% of the sample are actual PSNP public works participants, whereas, according to the World Bank, the poverty headcount ratio stands at 29.6% as of 2010 in Ethiopia. In the data, the majority of households receive in-kind transfers for all samples.

3.5 Results

3.5.1 Main Results

Tables 3.3 - 3.6 give the results for the impact of a cash transfer versus an equal valued in-kind transfer. As the prediction success rate for Sample 1 is much higher, I drop Sample

2 beyond a preliminary check. Most of the analysis concentrates on a parametric form of geographic location which is a cubic polynomial in latitude and longitude. The results are robust to linear and quadratic functions of geographic location as well.

Table 3.3 gives the impacts of cash versus in-kind transfers for the two samples and demonstrates that a cash transfer has a relatively large impact on household vulnerability to poverty: the typical estimate is negative, large in magnitude and statistically significant. Each row presents the impact of cash versus in-kind transfers on vulnerability for cubic polynomials of geographic location of two types - geographic coordinates and distance to capital. Column 1 looks at the estimate for Sample 1 and the coefficient in row 2 indicates that a cash transfer leads to a reduction of household vulnerability by 0.119 percentage points compared to an equal-value in-kind transfer. This suggests that receiving a cash transfer reduces the average household's probability of becoming poor within the next year by approximately 12%. This translates into a reduction of 18% in poverty since mean household vulnerability for Sample 1 is 0.647, and the effect is statistically significant at the 1% level. Row 1 Column 2 gives the estimate for Sample 2 and that a cash transfer leads to a reduction of household vulnerability by 0.122 percentage points compared to an equal-value in-kind transfer and this is significant at the 1% level. This again implies a reduction in the average household's probability of becoming poor within the next year by approximately 12%. This translates into a reduction of 20% in poverty since mean household vulnerability for Sample 2 is 0.613. Row 2 estimates, which uses a geographic polynomial in distance to capital, shows that the impacts are the same (around 12%) and hence the results are robust.

Table 3.4 gives an occupational decomposition of the impacts of a cash transfer versus an in-kind transfer on vulnerability for Sample 1. I consider 7 different groups, which are not mutually exclusive. The impact of the cash transfer ranges from 8 - 17% across groups. The largest beneficiaries of cash transfers are households with labor employed in agriculture and allied activities and this is also the most vulnerable group. Row 1 Column 3 indicates that the impact of a cash versus in-kind transfer on agricultural laborers is about 17% and the impact is significant at the 1% level. This translates into a 30% reduction in poverty for this group, as the mean vulnerability is 0.584. As agricultural workers are most affected by droughts, it makes sense that they are the largest beneficiaries of cash transfers. The impact is also substantial on private employees at 12% as these would likely include the self-employed. This translates into a 24% reduction in poverty for this group, as the mean vulnerability is 0.488. Government employees, manufacturers and constructors are the least impacted at 8 - 9%. These results serve as a good placebo check.

Table 3.5 gives the impacts of cash versus in-kind transfers on undesirable items, like alcohol and cigarettes and finds evidence for a paternalistic justification for in-kind transfers. Cash transfers lead to statistically significant (at 1% level) higher consumption of alcohol among beneficiaries. Compared to in-kind transfer recipients, cash transfer recipients, consume about 6 Birr ($0.26) more of alcohol per week. Considering the weekly average food budget of Sample 1, this comes to about an increase of 4% over in-kind recipients. Cash transfer recipients also spend about 4 Birr ($0.18) more on cigarettes in a month and this effect is statistically significant at the 10% level. Considering the monthly average non food budget of Sample 1, this comes to about an increase of 2% over in-kind recipients. As Banerjee and Duflo (2011) observe, decisions to save require a certain amount of self control from rich and poor alike. However, while the rich have a variety of tools at their disposal, like banks and financial advisors, to aid them in the process, the poor have to do a much harder job from their limited resources. Hence, providing them with in-kind transfers might make it easier for the poor to forgo "temptation" spending and force them not to be "myopic" about the future. However, since we are observing that overall vulnerability is declining for cash transfers, maybe the quantity is too small to be a big concern.

When governments inject cash or food into a community, these can cause supply / demand shifts, which might affect prices. Cunha et al (2014) find evidence that cash transfers lead to an increase in prices, especially in remote villages. Hence I test for future price effects of a cash transfer in the data, the result for which is given in Table 3.6. For this part of the analysis, I use the Direct Support (unconditional transfer) recipients of PSNP, as the data contained information on payment type for these households. I find a positive but small impact of cash versus in-kind transfer on the average price. A cash transfer leads to an increase in price by about 4 Birr ($0.18) compared to an equal-value in-kind transfer and the impact is statistically insignificant. This translates into an increase of 7% in prices over a 3 year period (and hence, a 2% annual inflation rate), as the average price in 2016 is about 56 Birr ($2.54). The yearly rate of 2% compares favourably with the average inflation rate of 8% prevalent in Ethiopia during the same period. There is insufficient data points to disaggregate the impact by region. This suggests that using a combination of food and cash transfers may act like automatic stabilizers on prices. There are various emerging options to deal with marked seasonal price fluctuations, like index-linking cash transfers to food prices, or deliver transfers half in cash and half in food, or distributing cash or food by season (Gentilini 2014). The last approach is similar to that of PSNP where food is provided in remote areas with unpredictable food prices. These methods of combining cash and food transfers are likely to have a number of advantages, although it may also entail considerable costs in terms of analytical planning and logistical coordination among modalities.

3.5.2 Robustness Checks

I employ a few alternative methods to test how robust the main results in my analysis are. As a first check, I use propensity score matching methods to analyze the average impact of cash versus in-kind transfer on vulnerability. I test the impacts for a wide range of calipers.[7] The results are given in Table 3.7 for Calipers 0.05 and 0.001. The impacts for Sample 1 range from 10 - 11%, which is consistent with my main results.

As a second robustness check, I apply my main empirical strategy on actual PSNP public works participants in the data. This is a relatively small sample of 361 households. At a

[7] A caliper means the maximum tolerated difference between matched subjects in the propensity score.

first glance, the impact is much lower than the average impact in my main results. Table 3.8 shows that the impact of cash transfers versus in-kind transfers on actual PSNP public works participants in the data is about 2% reduction in vulnerability to poverty, and the impact is statistically significant at the 10% level. However, the treatment-on-the-treated (TOT) estimate should take into account the actual take up of the program. As of 2010, the headcount poverty ratio in Ethiopia stands at 29.6%. Hence, in the data, approximately 1557 households should be participating in the public works PSNP program, whereas we see only 7% take up. Thus, I need to divide the impact estimate by the difference in proportion treated ($\frac{361}{1557} = 0.2$) to get the actual TOT impact. When I do this, the impact estimate is 10%, which is close to my main results.

3.5.3 Discussion

The validity of the results reported in this paper depend critically on the correct estimation of PSNP public works samples and the payment type variable. Berhane et el (2016) based their PSNP criteria on official targeting criteria, along with their own assessment of how these have been implemented in localities. The 71% prediction success rate that I get for Sample 1 alleviates fears that the government didn't follow their own rules but also tells us that a number of people who should have been eligible for the program may not have taken it up. Also, Table 3.2 suggests that actual beneficiaries are positively selected from the pool of potential beneficiaries, especially for Sample 1. This suggests that the effects for a more representative group should be larger. The ITT estimates, thus, gives us a potentially substantial lower bound of the results.

The prediction success rate for the payment type variable is around 60% when I compare with Direct Support clients. There could be two reasons for this - (a) There is measurement error in the market prices. The government assignment might be using older prices, as when I compare proportions of cash versus kind of actual payment type with predicted payment type, it appears to be underestimating cash. (b) There is some difference in the assignment of cash versus food to Direct Support clients as compared with public works beneficiaries. For instance, it is possible that some beneficiaries of the unconditional transfers are invalids (in which case transportation would be a problem), and the program accommodates this with a cash payment, thus inflating the proportion on cash. In either case, it's difficult to know how well I am estimating payment type.

Finally, since the ITT impacts are larger than the TOT impact, there is a possibility that there are considerable spillover effects from a cash based public works program. For example, public works may provide a bridge to more permanent employment in the formal sector. As Andrews and Kryeziu (2013) note, public works programs may have an important role in promoting social cohesion through three main pathways: promoting voice and participation through program processes; improving social inclusion and equality through temporary labor market participation; smoothing social tension and building trust in response to sudden shocks, as well as longer term fragility.

3.6 Conclusion

Using a geographic polynomial regression, this paper has analyzed the impacts of cash versus in-kind transfers on households eligible for PSNP in Ethiopia on vulnerability to poverty. The results suggest that the impacts of a cash transfer on poverty reduction are positive and significant, but there are associated increases on spending on undesirable items. Hence, food might have a role to play as well, especially in controlling prices. Thus, a combination of cash and food transfers under the same program framework seems to hold considerable appeal: as demonstrated by the PSNP Ethiopia, a rightly-calibrated mix of transfers could help manage implementation and livelihood risks posed by high and volatile food prices, as well as by more predictable but marked seasonal patterns. However, in choosing the "winner", there is need for more nuanced and rigorous cost-effectiveness analyses. Gentilini (2014) reviews costs of cash and food transfer programs and only in two cases finds it possible to examine a fuller measure of program efficiency that accounts for food procurement costs.

The literature on the cash versus food debate has largely been fueled by randomized controlled trials which are short term interventions. In contrast, this paper has looked at the impacts of cash versus food in the context of a long standing program. Also, the evidence till date has been largely based on food consumption, calories and dietary diversity data, whereas I look at the actual objective of a transfer program, poverty reduction. This research suggests that conditional cash transfers may be most successful in improving households' living standards, but at the same time food may act like an important gatekeeper.

Table 3.1: Sub Groups Summary Statistics

Variable	Sample 1	Sample 2	PSNP Participants	All
Vulnerability	0.647	0.613	0.705	0.603
Consumption of food last 7 days (Birr)	171.293	161.662	159.867	187.186
Consumption of non food last 1 month (Birr)	209.205	208.908	137.621	242.116
Households	2468	977	361	5256
Proportion receiving cash transfers (%)	41.61	38.18	43.49	43.21

Table 3.2: Means Tests

Variable	Sample 1	Sample 2
	(1)	(2)
Food Consumption	32.196 (20.941)	1.630 (16.544)
Non Food Consumption	78.178** (36.961)	74.027*** (18.619)
Proportion cash	-0.016 (0.048)	0.111*** (0.033)
Annual Mean Temperature	-1.413 (3.578)	-12.412*** (2.485)
Annual Precipitation	262.572*** (39.919)	396.560*** (24.640)
Elevation	-15.438 (59.496)	158.028*** (40.146)
Potential Wetness Index	0.058 (0.259)	-0.022 (0.182)
Livestock	0.068 (0.090)	-0.217*** (0.045)
Land	408.494 (1035.551)	-687.096 (3313.778)

Note: T-tests for differences in means between predicted and actual samples, for covariates of Equation (1). Standard errors are reported in parentheses. ***,**,* indicates significance at the 1%, 5%, 10%-level, respectively.

Table 3.3: Impact of Cash versus In-kind Transfers: Vulnerability

Specification	Sample 1	Sample 2
	(1)	(2)
(a)Cubic Polynomial in Latitude and Longitude		
cash	-0.119***	-0.122***
	(0.012)	(0.017)
R^2	0.243	0.239
(b)Cubic Polynomial in distance to Addis Ababa		
cash	-0.121***	-0.117***
	(0.012)	(0.017)
R^2	0.251	0.247

Note: All regressions include geographic controls. Robust standard errors, adjusted for clustering by enumeration area, are reported in parentheses. ***,**,* indicates significance at the 1%, 5%, 10%-level, respectively.

Table 3.4: Impact of Cash versus In-kind Transfers: Vulnerability Across Occupational Groups

Occupational Group	Mean	N	*cash*	R^2
	(1)	(2)	(3)	(4)
Agriculture and Allied Activities	0.584	55	-0.174*** (0.051)	0.584
Sales & Services	0.543	131	-0.100** (0.040)	0.372
Private Employees	0.488	204	-0.117*** (0.029)	0.286
Shopkeepers	0.483	65	-0.095* (0.053)	0.329
Manufacturers & Constructors	0.461	101	-0.077** (0.043)	0.346
Government Employees	0.460	255	-0.087*** (0.029)	0.259
Teachers	0.439	98	-0.102** (0.046)	0.325

Note: All estimates are reported for occupations within Sample 1. All regressions include geographic controls and cubic polynomial in latitude and longitude. Robust standard errors, adjusted for clustering by enumeration area, are reported in parentheses. ***,**,* indicates significance at the 1%, 5%, 10%-level, respectively.

Table 3.5: Impact of Cash versus In-kind Transfers: Temptation Spending

	Alcohol	Cigarettes
	(1)	(2)
cash	5.761***	4.179*
	(1.797)	(2.229)
R^2	0.033	0.060

Note: All estimates are reported for Sample 1. Regressions include geographic controls and cubic polynomial in latitude and longitude. Robust standard errors, adjusted for clustering by enumeration area, are reported in parentheses. ***,**,* indicates significance at the 1%, 5%, 10%-level, respectively.

Table 3.6: Impact of Cash versus In-kind Transfers: Prices

	Average Price (Birr)
	(1)
cash	3.974
	(20.314)
R^2	0.079
N	132

Note: Sample comprises Direct Support clients under PSNP. Regressions include geographic controls and cubic polynomial in latitude and longitude. Robust standard errors, adjusted for clustering by enumeration area, are reported in parentheses. ***,**,* indicates significance at the 1%, 5%, 10%-level, respectively.

Impact of Cash versus In-kind Transfers on Vulnerability: Robustness

Table 3.7: Propensity Score Matching

	Caliper 0.05	Caliper 0.001
	(1)	(2)
ATT	-0.101***	-0.105***
	(0.009)	(0.009)

Table 3.8: Impact on Actual PSNP Participants

	Vulnerability
	(1)
cash	-0.022*
	(0.013)
R^2	0.142
N	361

Note: Table 7 estimates are reported for Sample 1. Table 8 regression includes geographic controls and cubic polynomial in latitude and longitude. Robust standard errors, adjusted for clustering by enumeration area, are reported in parentheses. ***,**,* indicates significance at the 1%, 5%, 10%-level, respectively.

Chapter 4

Poverty and the Right to Food

4.1 Introduction

Poverty is a complex, multifactorial concept reflecting a low level of well-being and continues to be a major challenge in Asia and the Pacific, where the majority (approximately 75%) of the poor in developing countries resides. It is both a cause and an effect of food insecurity, and according to FAO's estimates, developing regions also house the bulk of the world's hungry people (827 million), where the prevalence of undernourishment is now estimated at 14.3%. Shocks to food security, like a sudden, dramatic collapse of food availability or access can cause permanent problems even if the underlying disruption, say of food prices, local agricultural production or employment, is short-lived. The permanent consequences of such transitory phenomena arise due to the existence of poverty traps, so the two concepts are interlinked. As a growing literature on poverty dynamics emphasizes, there is a fundamental difference between opening up a pathway out of poverty or 'cargo net' interventions that people can use to climb or be lifted over obstacles, and blocking a slide into poverty or 'safety net' interventions that preserve productive assets so as to enable independent recovery once the shock has passed (Barrett and Lentz 2009). Picking the right policy to help a given poor subpopulation depends on an accurate understanding of poverty dynamics.

The right to food is a basic human right, and is recognized as an explicit right in 9 countries[1] and is implied in broader human rights in various others. From the 1996 World Food Con-

[1] Bolivia (art. 16), Brazil (art. 6), Ecuador (art. 13), Guyana (art. 40), Haiti (art. 22), Kenya (art. 43), South Africa (art. 27.1), Nepal (art. 18.3) and Nicaragua (art. 63). Knuth and Vidar (2011)

ference, food security exists when all people at all times have physical and economic access to sufficient food to meet their dietary needs for a productive and healthy life. Food security has three dimensions - *availability* of sufficient quantities of food of appropriate quality, supplied through domestic production or imports; *access* by households and individuals to adequate resources to acquire appropriate foods for a nutritious diet; and *utilization* of food through adequate diet, water, sanitation, and health care. Timmer (2004) contends that for the purposes of government policy, food security can be thought of as a continuous spectrum. It starts from the micro perspective of nutritional well-being of individuals, and goes all the way to the macro perspective that assures regular supplies of food in national, regional, and local markets. The challenge of food policy is to create an environment where access to purchasing power, nutritional knowledge, and health care within each individual household assures adequate demand for food in those markets. This would guarantee food security at both ends of the micro-macro spectrum.

Vyas and Bhargava (1995) identify that, in a developing economy, there are essentially four ways by which poverty can be alleviated. The first is the 'trickle down' or the 'spread' of growth, the second is to create employment opportunities for the target group of the poor, the third is a policy on relative prices like food subsidies, the fourth is direct income transfers. Food security interventions would typically fall under the third or fourth categories. The important question then arises, which issue to address first? Should the government invest in 'cargo net' long term solutions to remove poverty or create 'safety net' precautions first, like food price subsidies, food stamp programmes, and food supplementation schemes? This research looks into the question of whether there are policy options available for developing countries to achieve food security while enhancing their capacity to achieve long-term economic growth and development. This question necessitates moving beyond the adequacy-stability divide and making the distinction between support-led short-run food security and growth-mediated long-run food security. Long-run or growth-mediated security has to do with enhancing the development of human capabilities for meeting food and other basic needs. Short-run or support-led security in the form of public and private support systems (e.g., food aid programmes) is a reflection of society's aversion to starvation and other less terminal forms of nutritional deprivation and places less emphasis on growth. This raises possible trade-offs between short-run and long-run benefits (and costs) of public action for enhancing household food security and for most developing countries, especially those in early stages of transition from a centrally planned to a market economy, tight fiscal resources demand a serious recognition of these trade-offs.

Thus, adequate linkages are required between the two tracks of direct or immediate and long-term interventions. While social protection instruments can establish a bridge between the two tracks, for making the transition from humanitarian assistance for chronic needs to longer-term development, a vital component is public investment in infrastructure. Food insecurity is often less the result of a lack of food than a distance from food. The food supply chain connecting agricultural producers to major centers of consumption and export markets relies on multimodal and seamless transportation systems (like, railroads, highways, ports and airports), which developed economies are equipped with. Modern infrastructures of transportation, telecommunications, and energy along the food supply chain facilitate cheaper long distance product flows as well as greater commercialization and trade between complementary regions. The situation in developing economies with chronic food insecurity, like Africa, is very different at all stages of agricultural production, storage, and distribution, with the supply chains being generally underdeveloped and underfunded. According to the State of the World 2011 author, 150 million tons of grain is lost per year in low-income countries, which is 6 times the amount needed to meet the needs of all the hungry people in the developing world. Although the report states food losses are high in both industrialized and developing countries, it distinguishes between the two groups, stating that "food losses in industrialized countries are as high as in developing countries, but in developing countries more than 40 percent of food losses occur at post-harvest and processing levels, while in industrialized countries, more than 40 percent of food losses occur at retail and consumer levels". Although Africa may be characterized as being in a situation of chronic food deficit, more than 85% of the rural poor live on land that has a medium to high potential for increased productivity. If harnessed properly, this untapped potentiality could help to alleviate the chronic food security problem. In India, the Public Distribution System (PDS) is the most important food security network, both in terms of coverage and public expenditure, but is riddled with inefficiencies like poor targeting and corruption. The government of India spends roughly 1% of GDP on this system, and despite India having the largest stock of grain in the world besides China, 21% of the population remains undernourished.

Rights-based advocates, such as La Via Campesina's food sovereignty movement, India's Right to Food Campaign, and the Food and Agriculture Organization's Voluntary Guidelines to Support the Progressive Realization of the Right to Adequate Food in the Context of National Food Security, argue that some households need long-term, state sponsored support and are reviving an interest in developing social protection programs to provide regular, continued support to those facing chronic food insecurity. Several developing countries have implemented social protection programs, such as the Productive Safety Net Program in Ethiopia, the Hunger Safety Net Program in Kenya, Bolsa Familia in Brazil and Oportunidades in Mexico. Most OECD countries have similar, targeted social protection programs. Devereux (2009) argues that governments and agencies routinely suffer 'response failures' in halting or incompetent attempts to respond to food insecurity resulting from supply or demand crises and such failures commonly result in worsening food insecurity. Poorly conceptualized or implemented assistance programs can adversely affect communities, leaving them more vulnerable to food insecurity and this paper tries to bring out how poverty traps might be magnified under such circumstances.

For instance, India's National Food Security Bill, which guarantees subsidized food grains to every household below the poverty line, an estimated 820 million people, is a very ambitious plan, especially in a country with poor infrastructure, like poor public distribution system. The objective of the bill is to bring some security in people's lives and make it easier for them to meet their basic needs, protect their health, educate their children, and take risks.[2] But the bill does not address other equally vital areas of food security like access to basic sanitation facilities and clean water, public health education and the root causes of malnutrition. A wide range of microeconomic studies have documented the fact that infrastructure may affect health outcomes, and hence standards of living, which is critical to productivity, through a variety of channels. Where there are no clinics or hospitals available, or where lack of roads or bridges makes them inaccessible, people cannot access the medical services that they require to be healthy and productive, even if they have access to adequate food. The lack of safe drinking water and a scarcity of hygienic sanitation services are primary causes of disease and poor health in many low-income countries. For example, deaths from diarrhea, a direct result of poor water quality, are the highest in Sub-Saharan Africa. In addition to health, education is another important factor that enables people to overcome extreme poverty. Where there are no schools - another essential element of basic infrastructure - it becomes difficult to educate children or adults, leading to a cycle that deprives later generations of learning. Lack of access to basic infrastructure also imposes significant constraints on the allocation of time in poor countries. In Sub-Saharan Africa, women spend between 0.9 and 2.2 hours per day collecting water and fuel wood, time which could be better utilized if such processes were mechanized. Lack of proper roads and modes of transportation increases commute time of workers, especially in rural areas, such that a lot of time is wasted which could be otherwise productively employed. Infrastructure may also improve the efficiency of time allocated to specific activities. For instance, access to electricity might enable improved education of children, which is a critical component of adult productivity, and hence human capital formation. Lack of infrastructure may also lead to lack of employment by acting as a disincentive to investment. Companies which find it difficult to produce and sell goods in an area with inadequate roads, electricity or water supply would not want to set up the

[2] Development economist Professor Jean Drèze, one of the architects of the original, 2011 version of the bill (Source: Wikipedia)

factories or businesses that could potentially generate employment, improve living standards and reduce poverty.

While the objectives of such social interventions are commendable, the consideration in designing such programmes must be that these treat the causes, not the symptoms, of the food-insecurity or malnutrition problem. The usual root of the malnutrition problem is long-run poverty, which in turn arises from either incapability of certain household groups to raise their entitlements, or unforeseen shocks, such as drought or flood which reduce their entitlements. Without developing these groups' income-generating capacity, there will not be a situation in which social intervention are no longer needed. The challenge is to use food-linked transfer programmes that will lead to a greater access to food in the short run while creating a capacity within the household to secure food independently in the longer run and such opportunities do exist. One such opportunity is to couple the use of food and credit assistance with the formation of human capital through nutrition, health, and education improvement, such that the poor can get involved in the development of small-scale enterprises and other self-help activities. Another is the linking of food subsidies to the development of infrastructure, such as food-for-work programmes. This will raise the incomes of household recipients beyond the programme period by generating employment opportunities. In fact, evidence shows that poverty alleviation programmes taking advantage of the synergies that exist among food, family care, and access to health and infrastructure services, have a much higher chance of treating the root causes of malnutrition and long-run food insecurity than what independently running programmes, like nutrition programmes, food subsidy programmes, credit programmes, and so on, could accomplish.

This paper explores the synergies that exist among subsistence level food, human capital and infrastructure that can be used by an economy to escape a poverty trap, such that both the short term objectives of increasing availability of food and long term objective of building a pathway out of poverty can be achieved.

4.2 Literature Review

The literature on food security / insecurity is peppered with discussion papers on general overview of concepts and measurements or case studies of measures taken in specific regions(Barrett and Lentz 2009, Barrett et al 2009, Timmer 2004, Baro and Deubel 2006, Vyas 2000, Swaminathan 2008), without any concrete theoretical models exploring the dynamics between food security and poverty alleviation. The closest to this paper is Beasely and Kanbur (1988) which analyses the impact of different subsidy schemes on incomes and poverty and compare their relative benefits. In contrast, this paper combines three spheres in the existing literature, that is, subsistence consumption, human capital and infrastructure, to build a model which can explain the response of an economy caught in a poverty trap to changes in food security measures. This paper captures the idea of a food security measure as raising the level of subsistence consumption and assesses the resulting impacts, which has previously not been done in the literature.

The source of poverty trap in my model is the nature of human capital accumulation. Human capital and poverty traps has a long standing history (Azariadis and Drazen 1990, Das and Chakraborty 2005, Becker et al 1990, Ceroni 2000, Galor and Tsiddon 1997, Galor and Zeira 1993, Getachew 2008). The mechanism my paper follows in defining the evolution of human capital is different from the existing literature in two ways. Firstly, it links the process of human capital formation to the subsistence level of consumption which is taken as a proxy for nutritional status. The justification for tying subsistence consumption to human capital comes from the link between nutrition status and work capacity, for which there is vast documentation[3]. To capture the 'basic needs' and 'capabilities' idea in the literature, labor productivity is a function of the capital stock of the economy above a certain level of subsistence consumption. The intuition behind this link can be thought of as subsistence consumption raising the 'capabilities of labor such that they are able to respond to market

[3]see Dasgupta 1997

incentives and vary the effort they put in according to the wages and capital stock. At low levels of subsistence this is not possible because their capabilities are binding. Secondly, above the minimum level of subsistence, this paper incorporates another component to human capital accumulation. This part is determined by the stock of infrastructure in the economy and incorporates the idea that even with adequate nutritional status, a part of the efficiency of a worker is beyond his control and depends on the degree of conducive socio-economic factors.[4] For instance, if suitable modes of transportation are not present in a region, and a worker has to commute over long distances by foot, then this reduces the energy levels he has left for work, which would reduce his efficiency at work. The existing literature has either looked at human capital accumulation as a conscious decision which varies according to returns (Becker et al 1990), or as a result of factors beyond an agent's control (Getachew 2008), but has not combined two approaches, which this paper does. This paper takes the approach that labour productivity, when basic needs are not a constraint, is an outcome of both conscious decisions and external factors.

In my model, subsistence level consumption has a feedback effect on human capital accumulation, and hence has a role to play in the generation of poverty traps. Linkages between subsistence level consumption and poverty traps either directly or indirectly, via the nutrition-productivity pathway have been examined sporadically in the literature (Makdissi and Hung 2004, Grass and Engstrom 2011, Dasgupta 1997, Pitt et al 1990). My model is an extension of the work of Azariadis (1996) on impatience traps, where a human capital angle is introduced. In Azariadis (1996), subsistence consumption is a share of next period's output and the share-of-GNP parameter has a discontinuity and its value hinges on a critical level of capital stock. Thus, if his argument is extended, the implication from his model for a simple food security measure where this share parameter is exogenously raised above the critical

[4]Also, while there is ample literature on the relationship between infrastructure and growth and inequality (Barro 1990, Turnovsky 1997, Aschauer 1988, Aschauer 1989, Bom and Ligthart 2010, Caldern and Servn 2004, Glomm and Ravikumar 1992, Agenor 2009), its importance in the context of food security has not been studied by economists

level turns out to be that it would enable the economy to escape the poverty trap. His model also has strong positive implications for foreign aid, since this framework leads naturally to the idea of loans from rich to poor countries such that the rate of impatience in poor countries is reduced sufficiently, that is, the share parameter is raised above the critical level, to make permanent development possible. This seems too simple to capture the complex dynamics of food security and aid measures accurately, given the mixed empirical evidence on the effectiveness of such measures in poverty alleviation and augmenting the underlying assumptions seemed called for, which this paper does. The model employs a slight variation of the Newman-Read function to explain one component of human capital formation above a critical level of subsistence consumption, which is consistent with the approach followed in Becker et al (1990). Getachew (2008) uses a similar functional form, but to describe the production process. This choice of the functional form is based on the convex work capacity curve employed in Dasgupta and Ray (1986). As will be demonstrated later, with the inclusion of the feedback effect of subsistence consumption on human capital, we no longer get such strongly favorable implications for food policy as in Azariadis (1996), and this is more consistent with expectations.

Further, as per Dasgupta (1997), the idea of understanding extreme poverty by inquiring into the consumption of easily measurable basic needs as opposed to estimating income or expenditure, has much to commend it and comparatively less work has taken this approach. The focus of the literature on subsistence level poverty traps has been in the context of an agricultural economy, whereas my model is a more general application to any developing economy.

4.3 The Model

In households facing continuing hunger, young children do not receive adequate nutrition and this results in inadequate development of physical and mental capacities of the new generation. A physically and mentally weak new generation is doomed to continue being hungry and will have little chance of escaping from poverty. Poverty stays because hunger has made it dynastic. Hence, to take into account this inter-generational effect, I consider a simple overlapping generations model which consists of identical, two-period lived households. Individuals work during youth and supply labour inelastically and earn wages. In old age, that is the second period of their lives, they retire and consume their savings. Population grows at the rate n, which is the growth rate of the labour force, that is, the young population. Individuals choose consumption in youth, c_{1t} and old age,c_{2t}, which determines savings and hence capital accumulation. In addition to individuals, the economy is populated by firms and an infinitely-lived government. Firms are perfectly competitive and produce a marketed good using private capital and labor as inputs. The government imposes a flat rate income tax $\tau < 1$ on the young population which it invests in public capital in the form of infrastructure. Infrastructure does not enter the production function of firms directly, but rather augments human capital formation. It is nonexcludable and partially rival. All government services are provided free of charge. It cannot borrow and therefore must run a balanced budget in each period.

Households maximize:

$$V_t = log(c_{1t} - x_{1t}) + \beta log(c_{2t} - x_{2t})$$

subject to:

$$c_{1t} + \frac{c_{2t}}{r_{t+1}} = (1-\tau)w_t$$

Where, (c_{1t},c_{2t}) and (x_{1t},x_{2t}) are 1st period and 2nd period consumptions and subsistence consumptions respectively. Then the first order conditions are given by:

$$(1+\beta)(c_{1t} - x_{1t}) = (1-\tau)w_t - x_{1t} - \frac{x_{2t}}{r_{t+1}} \tag{4.1}$$

$$(1+\beta)(c_{2t} - x_{2t}) = \beta r_{t+1}\{(1-\tau)w_t - x_{1t} - \frac{x_{2t}}{r_{t+1}}\} \tag{4.2}$$

Then individual savings is given by:

$$(1-\tau)w_t - c_{1t} = \frac{\beta}{1+\beta}\{(1-\tau)w_t - x_{1t}\} + \frac{1}{1+\beta}\frac{x_{2t}}{r_{t+1}} \tag{4.3}$$

Let the production process be given by:

$$Y_t = {K_t}^{\alpha}(h_t L_t)^{1-\alpha}$$
$$\Rightarrow y_t = {k_t}^{\alpha}$$

Perfect factor markets imply:

$$w_t = (1-\alpha)h_t {k_t}^{\alpha}$$
$$r_t = \alpha {k_t}^{\alpha-1}$$

The government invests its tax earnings on infrastructure and must maintain a balanced budget at all times. That is, it can neither finance deficits by issuing debt nor run surpluses by accumulating assets. Then the government's budget constraint is given by:

$$G = T = \tau Y_t$$
$$\Rightarrow \tau y_t = g \tag{4.4}$$

Then, private capital accumulation in the economy is given by, using (3):

$$K_{t+1} = ((1-\tau)w_t - c_{1t})h_{t+1}L_t$$
$$\Rightarrow (1+n)k_{t+1} = \frac{\beta}{1+\beta}((1-\tau)w_t - x_{1t}) + \frac{1}{1+\beta}\frac{x_{2t}}{r_{t+1}} \tag{4.5}$$

Let the subsistence consumption vector (x_{1t},x_{2t}) be given by (0,$\bar{x}{k_{t+1}}^{\alpha}$). Then substituting into (5) we get:

$$(1+n)k_{t+1} = \frac{\beta}{1+\beta}(1-\alpha)(1-\tau)h_t {k_t}^{\alpha} + \frac{1}{1+\beta}\frac{\bar{x}}{\alpha}k_{t+1}$$
$$\Rightarrow k_{t+1} = \frac{s(1-\alpha)(1-\tau)}{(1+n)-(1-s)\frac{\bar{x}}{\alpha}}h_t {k_t}^{\alpha}$$
$$\Rightarrow k_{t+1} = \chi(1-\tau)h_t {k_t}^{\alpha} \tag{4.6}$$

where $s = \frac{\beta}{1+\beta}$ and $\chi = \frac{s(1-\alpha)}{(1+n)-(1-s)\frac{\bar{x}}{\alpha}}$.

Human capital accumulation has two components above a certain level of subsistence. One part is the efficiency of the time allotted to work determined by access to infrastructure. It is assumed that infrastructure enhances the time allocated to work. In particular, greater access to better health services, education, roads or electricity allows labourers to devote less 'raw' time to work, while providing the same effective time. The efficiency of time increases as the ratio of public to private capital increases, but involves decreasing returns to private inputs if the government inputs do not expand in a parallel manner. The general concept behind including g as a separate argument here is the idea that private inputs are not a close substitute for public inputs. The second component of human capital formation above a minimum level of subsistence is a process of the decision making of households of how much they want to enhance their skills or their effort level, which depends on the returns to private capital. When the returns to private capital are high, that is the stock of private capital in the economy is low as compared to human capital,then the returns to human capital are relatively low and hence there is less incentive to invest in human capital formation. As the private capital stock to human capital in the economy rises, the relative returns to human capital rises, and the household becomes more willing to invest in human capital accumulation and the stock of human capital thus rises. Eventually the rate of return on human capital starts falling as it becomes increasingly difficult to absorb more knowledge, and hence even with further rises in the private capital to human capital ratio, human capital accumulation declines. This gives rise to an S shaped curve for the second part of human capital formation above the minimum level of subsistence. Below the minimum level of subsistence, the productivity of labourers are simply given by the stock of infrastructure in the economy as they are capacity bound. Thus, summarizing, the process of human capital accumulation is given by:

$$h_t = \begin{cases} (\frac{g}{k_t})^{\alpha} + {k_t}^{\theta} e^{-\lambda(k_t) ln^2(k_t)}, & \text{if } \bar{x} \geq c \\ g, & \text{otherwise} \end{cases} \tag{4.7}$$

This element of non-convexity in human capital formation is not unusual in economics. Galor and Tsiddon (1997) employ a similar functional form for human capital accumulation, where they assume that the production function of human capital is characterized by complementarity between the parental human capital effect and the private resources invested in the production of human capital. In Galor and Zeira (1993) as well, non-convexities appear in the form of indivisibility in investment in human capital, which leads to non-ergodic dynamics and to multiple long-run wealth distributions. Then (4.6) becomes:

$$k_{t+1} = \begin{cases} \chi(1-\tau)g^{\alpha} + \chi(1-\tau){k_t}^{\alpha+\theta-\lambda(k_t)ln(k_t)}, & \text{if } \bar{x} \geq c \\ \chi(1-\tau)g{k_t}^{\alpha}, & \text{otherwise} \end{cases} \tag{4.8}$$

Then it can be shown, that under certain parametric restrictions, the solution to the system given by (4.8) yields 4 steady state equilibria, 3 of which are stable and one threshold unstable (Galor and Tsiddon (1997),Getachew (2008)). Figure 4.1 represents one possible case. From figure, $\tilde{k_1}$,$\tilde{k_2}$ and $\tilde{k_4}$ are stable, whereas $\tilde{k_3}$ is unstable. In this model, a simple food security measure would be to exogenously raise the subsistence level consumption, that is $\bar{x}$. Then, referring to Figure 4.1, the effectiveness of the food policy in pulling an economy out of a poverty trap depends on whether $\tilde{k_2}$ > or $\leq$ $\tilde{k_3}$. As it is shown in the figure, if $\tilde{k_2} < \tilde{k_3}$, then even raising $\bar{x}$ above c would not be helpful, in fact, the economy would move to an even lower steady state given by $\tilde{k_1}$. Intuitively, we can say, the reason for this is, when both private capital stock and infrastructure are low, both the conscious incentive to accumulate human capital and the efficiency of time determined by external factors is low. At low levels of subsistence, while there is an upper bound to human capital formation, there is also the same lower bound. This is not the case with enhanced capabilities, since individuals are sufficiently well nourished such that they can now afford to put in less effort. Thus, human capital formation is not adequate and next period's output falls, reducing returns to private capital which acts as a disincentive to private savings and reduces private capital further. This further reduces human capital formation, and one effect reinforces the other till the economy eventually moves to $\tilde{k_1}$. If however, $\tilde{k_2} > \tilde{k_3}$, that is the initial infrastructure is not too low, then the economy moves to the high income equilibrium given by $\tilde{k_4}$ if the subsistence share parameter is raised above c. This illustrates the important role initial level of capital stock and infrastructure plays in the determination of the outcome of food policy.

Next, I examine the effect of an increase in infrastructure combined with a food security measure. Given the government's budget constraint, an increase in g must be financed by an increase in the tax rate, τ. Then, looking at (6), this has two opposing effects. An increase in τ tends to shift the k_{t+1} locus downwards, while the increase in g, and hence human capital tends to shift the locus upwards. The net effect depends crucially on which effect dominates. We can write the production function in per capita terms (rather than per unit of effective labour) as, suppressing the time scripts:

$$\frac{Y}{L} = (\frac{K}{L})^{\alpha} h^{1-\alpha}$$

$$\Rightarrow \frac{y^L}{k^L} = (\frac{h}{k^L})^{1-\alpha} = \phi(\frac{h}{k^L})$$

$$\Rightarrow \frac{h}{k^L} = \frac{h}{y^L}\phi \tag{4.9}$$

Now, we can write (6) in per capita terms as:

$$k = \chi(1-\tau)(\frac{h}{k^L})^{1-\alpha} k^L$$

$$\Rightarrow k = \chi(1-\tau)\phi k^L = A k^L$$

Then, the effect of an increase in τ, and hence $\frac{g}{y}$, depends on the term A. Frist note, an increase in $\frac{g}{y}$ will imply an increase in $\frac{h}{y}$ and hence,$\frac{h}{y^L}$, and hence we can analyse the effect of that instead. So,

$$\frac{\partial k}{\partial \frac{h}{y^L}} \approx \frac{\partial A}{\partial \frac{h}{y^L}} k^L$$

Now, we can write A as, substituting for τ:

$$A = \chi(1 - \frac{g}{y})\phi \geq \chi(1 - \frac{g}{y^L})\phi \geq \chi(1 - \frac{h}{y^L})\phi$$
$$\text{i.e., } A \geq \chi(\phi - \frac{h}{y^L}\phi) = \chi(\phi - \frac{h}{k^L})$$

Thus, we get:

$$\frac{\partial A}{\partial \frac{h}{y^L}} \geq \chi\phi(\phi' - 1)$$

Then a sufficient condition for $\frac{\partial A}{\partial \frac{h}{y^L}} > 0$ is $\phi' > 1$. This would hold if $\frac{h}{k^L}$ and hence, $\frac{g}{k^L}$ is small enough, that is the government size is small. We can typically expect this to hold in poor nations with relatively underdeveloped infrastructure. Then, when this condition holds, an increase in g along with a food security measure that raises $\bar{x}$ above c, could potentially enable the economy to escape the poverty trap as illustrated in Figure 4.2. The rise in g shifts the k_{t+1} locus upwards (as shown by the dashed curves), and with adequate infrastructure, could lower the threshold unstable equilibrium point below the initial equilibrium with low level of subsistence. Then, coupling this with an increase in $\bar{x}$ above c enables the economy to move to the high income equilibrium.

4.4 Conclusion

This paper has shown via a simple model how the effectiveness of a food security measure in pushing an economy out of a poverty trap depends critically on the level of infrastructure in an economy. An important point to recognize in the model, however, is that raising the subsistence level of food is also necessary for the economy to get to the high income equilibrium. This brings out the idea that, while economic growth that provides lasting benefits to the poor is the surest path to sustainable poverty alleviation, for a large number of the hungry poor, there can be no growth without first overcoming today's hunger. A balance between 'safety net' and 'cargo net' policies are thus required for the economy to escape the poverty trap. The point this paper has demonstrated is that food policy alone is not sufficient. In this context, a note regarding foreign aid is required. As can be seen from the model, foreign aid which is channelled towards developing infrastructure while at the same time raising the level of subsistence consumption would be most effective in eliminating the poverty trap as there wouldn't be the detrimental effect of increased taxation on savings. The world's hungry poor need help to break out of the vicious cycle of poverty and malnourishment and get on a path of self-reliant growth. In many cases, this help is most useful when it comes in the form of well planned foreign assistance.

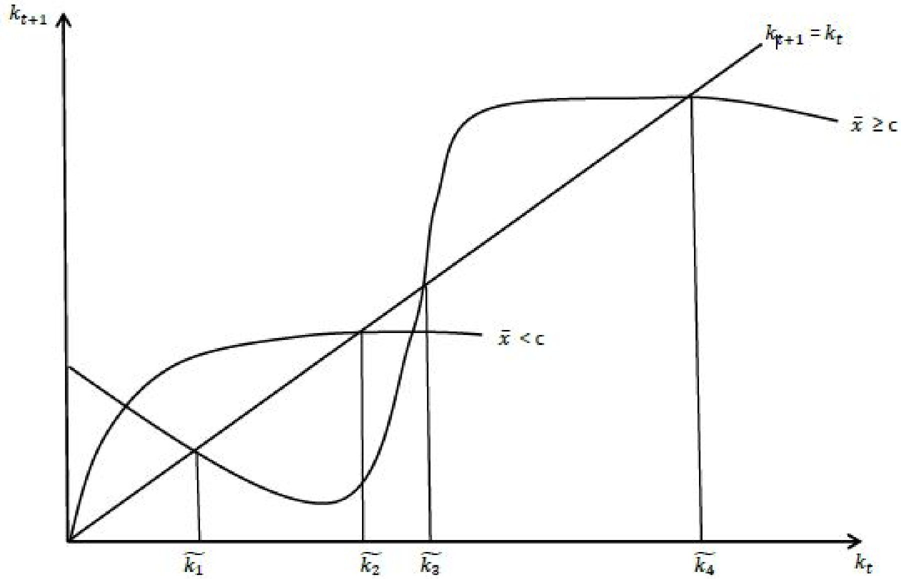


Figure 4.1: Multiple Equilibria and Poverty Traps

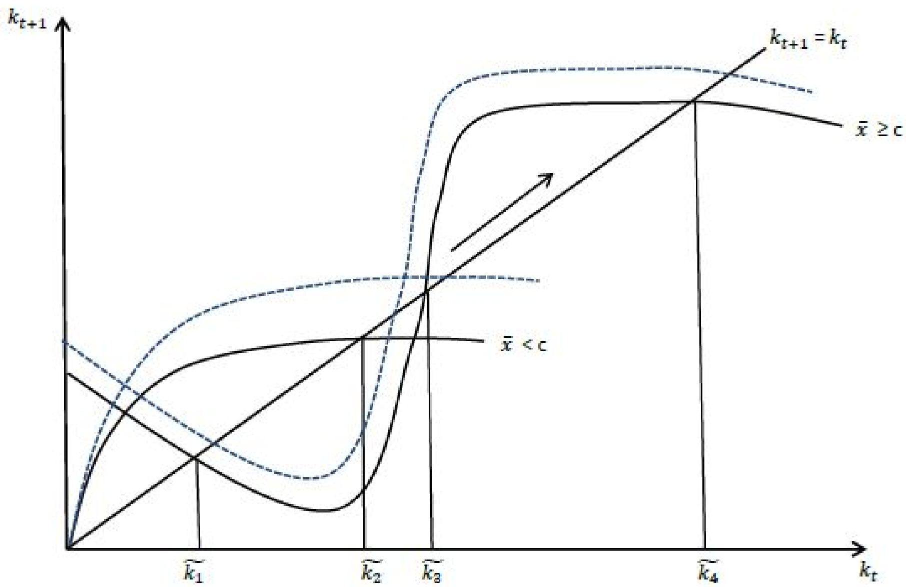


Figure 4.2: Effect of an increase in g

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Appendix

Vulnerability to Poverty Estimation

The vulnerability level of a household h at time t is defined as the probability that the household will find itself consumption poor at time t+1:

$$v_{ht} = Pr(c_{h,t+1} \leq z)$$

where $c_{h,t+1}$ is the household's per-capita consumption level at time t+1 and z is the appropriate consumption poverty line. The procedure for estimating household vulnerability is as follows (Chaudhuri et al. (2002)).

The stochastic process generating the consumption of a household h is given by:

$$lnc_h = X_h\beta + e_h$$

where, c_h is per capita consumption expenditure, X_h represents selected observed household and community level characteristics, β is a vector of parameters, and e_h is a mean-zero disturbance term that captures idiosyncratic factors (shocks) that contribute to different per capita consumption levels for households that are otherwise observationally equivalent.

The variance of e_h (and hence of ln c_h) is allowed to depend upon observable household characteristics in some parametric way. The estimates ($\sigma^2_{e,h}$) are generated assuming the following functional form:

$$\sigma^2_{e,h} = X_h\theta$$

β and θ are estimated using a three-step feasible generalized least squares (FGLS) procedure. Using the estimates $\hat{\beta}$ and $\hat{\theta}$ that are obtained, expected log consumption and the variance of log consumption can be directly estimated as follows:

$$\hat{E}[lnc_h|X_h] = X_h\hat{\beta}$$

$$\hat{V}[lnc_h|X_h] = \hat{\sigma}^2_{e,h} = X_h\hat{\theta}$$

for each household h. By assuming that consumption is log-normally distributed (i.e., that ln c_h is normally distributed), these estimates can then be used to form an estimate of the probability that a household with the characteristics, X_h, will be poor, i.e, of the household's vulnerability level.

$$\hat{v}_h = Pr(lnc_h < lnz|X_h) = \Phi(\frac{lnz - X_h\hat{\beta}}{\sqrt{X_h\theta}})$$