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GIFFEN BEHAVIOR: THEORY AND EVIDENCE*

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Abstract: This paper provides the first rigorous, empirical evidence of the existence of Giffen behavior, i.e., a situation in which consumers respond to an increase in the price of a good by demanding more of it. We begin by examining several theoretical approaches to the Giffen phenomenon and show that in each case Giffen behavior is closely associated with poor consumers' need to maintain subsistence consumption in the face of an increase in the price of a staple commodity. We then present evidence on the existence of Giffen behavior among extremely poor households in two provinces of China. In order to obtain an unbiased estimate of the key price elasticity, we conducted a field experiment in which we randomly subsidized households' primary dietary staple (rice in Hunan province and wheat flour in Gansu province). Using consumption data gathered before, during and after the intervention, we find strong evidence of Giffen behavior with respect to rice in Hunan province. We also find evidence for Giffen behavior in Gansu with respect to wheat; however, the evidence is less robust than for Hunan, due to the (unanticipated) failure of at least two of the theoretical conditions that appear necessary for Giffen behavior. Restricting the Gansu sample to households that meet these conditions provides stronger evidence of Giffen behavior.

KEYWORDS: Giffen Goods; Theory of the Consumer; Consumption; Poverty.
JEL Codes: D01, I30, O12

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I. INTRODUCTION

The "Law of Demand," which holds that as the price of a good increases, consumers' demand for that good should decrease, is one of the bedrock principles of microeconomics. However, economists have long recognized that the axioms of consumer theory do not guarantee that demand curves must slope downward. Alfred Marshall first publicized this idea in the 1895 edition of his *Principles of Economics*:

> *As Mr. Giffen has pointed out, a rise in the price of bread makes so large a drain on the resources of the poorer labouring families and raises so much the marginal utility of money to them, that they are forced to curtail their consumption of meat and the more expensive farinaceous foods: and, bread being still the cheapest food which they can get and will take, they consume more, and not less of it. (p. 208)*

Since Marshall's time, a discussion of "Giffen" behavior[1] has found its way into virtually every basic economics course despite there being no evidence that the demand for either bread or wheat was upward sloping in Britain during Marshall's time (Stigler 1947 and Koenker 1977). The standard textbook example of a Giffen good, the case of the potato during the Irish famine of 1845-1849, has also been discredited. Not only are there no data to support the claim (Stigler, 1947), but at a more basic level it is unlikely that consumption of potatoes could have increased when the price rose during the famine, at least in the aggregate, precisely because the price increase was caused by a shortage of potatoes due to a blight that destroyed much of the crop.[2]

The fact that there has to date been no convincing evidence of Giffen behavior stands as a minor embarrassment to economists, one that is reflected in the discussion of the Giffen phenomenon often being presented as a paradox of economic theory rather than as a real (or even possible) mode of behavior (e.g., Stigler, 1947).[3] This lack of evidence has prompted a range of reactions among economists. Some have interpreted it as support for the descriptive validity of the Law of Demand:

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[1] We use the term "Giffen behavior" rather than "Giffen good" to emphasize that the Giffen property is one that holds for particular consumers in a particular situation and therefore depends on, among other things, prices and wealth. Thus, it is not the good that is Giffen, but the consumers' behavior. The Giffen phenomenon should also not be confused with prestige or Veblen goods, where price signals quality and/or consumers desire the goods precisely because the price is high. Giffen behavior is a phenomenon that arises entirely within the neoclassical framework where consumers care about price only inasmuch as prices affect their budget sets, which rules out prestige goods.

[2] Another argument notes that with upward sloping demand in stable equilibrium (i.e., supply is flatter than demand), the supply reduction due to the famine would actually lower the price of wheat, not raise it. Dwyer and Lindsay (1984) present a summary of the basic case against the potato version of the Giffen paradox.

[3] Perhaps the best evidence to date is by Battalio et al. (1991), who find evidence of upward sloping demand curves among rats given limited 'budgets' and the choice between root beer and a quinine solution.

> *Perhaps as persuasive a proof [of the 'Law of Demand'] as is readily summarized is this: if an economist were to demonstrate its failure in a particular market at a particular time, he would be assured of immortality, professionally speaking, and rapid promotion while still alive. Since most economists would not dislike either reward, we may assume that the total absence of exceptions is not from lack of trying to find them.*
>
> --George Stigler (1987, p.23).

However, this line of argument has in turn raised questions about the pedagogical usefulness of the Giffen story:[4]

> *Since the Giffen paradox is not useful for understanding the Irish Experience, is it asking too much for future writers of elementary texts to find another example? Fictions have no place in the teaching of economics.*
>
> --Sherwin Rosen (1999, p. S313).

> *We shall have to find a new example of the positively sloping demand curve, or push our discussion of it deeper into footnotes.*
>
> --George Stigler (1947, p. 156).

Others' reactions to the lack of real-world validation for the Giffen phenomenon have been more extreme, interpreting it as an indictment of neoclassical consumer theory. Along these lines, Boland (1977) points out that not only is the theory unable to rule out Giffen behavior, it is also unable to explain why Giffen behavior is not observed. Put another way, if the neoclassical model is correct, then under certain (albeit uncommon) conditions, Giffen behavior should exist. If it has not been observed, it is either because the appropriate conditions have not been satisfied, the appropriate data have not been available to measure it, or our theory of the consumer is incomplete or flawed.[5]

The conditions under which we would expect Giffen behavior can be demonstrated by elaborating Marshall's statement. Imagine an impoverished consumer near a subsistence level of nutrition, whose diet consists of only two foods, bread and meat. Bread offers a high level of calories at low cost, while meat is preferred because of its taste (but provides few calories per unit currency). The consumer therefore eats a lot of bread in order to get enough calories to meet his basic needs, and with whatever money he has left over, he purchases meat. Now, if the price

[4] In our opinion, the primary role of the "Giffen paradox" in economic education is to provide a stark example of the difference between compensated and uncompensated elasticities and to illustrate the importance of wealth effects.

[5] Others have argued that it is not our understanding of consumers that is flawed, but rather our understanding of markets. For example, Dougan (1982) argues that markets with upward sloping demand curves are inherently unstable, and thus unlikely to be observed, while Nachbar (1998) shows in a general equilibrium framework that observing the equilibrium price and quantity of a good move in the same direction in response to a supply shock

of bread increases, he can no longer afford the original bundle of foods. And if he increases his consumption of meat, he will fall below his required caloric intake. So instead, he must increase his consumption of bread and cut back on meat.

Thus, although the price increase makes the staple relatively less attractive, the fact that the price increase makes the consumer so much poorer (in real terms) forces him to consume more bread. Translating this to the language of consumer theory, the conditions under which Giffen behavior is likely to be observed therefore include that the good in question be strongly inferior and that expenditure on that good comprise a large portion of the consumer's budget. As can be seen from the elasticity version of the Slutsky equation, $\varepsilon = \varepsilon^h - b\varepsilon_w$, where ε is the observed price elasticity of demand, ε^h (< 0) the Hicksian compensated elasticity, ε_w the wealth elasticity, and b the budget share of the good, only then can the negative wealth effect of an increase in price be large enough to offset the pure substitution effect. We will argue that such circumstances are most likely to arise when the consumer faces a subsistence constraint and show that the subsistence motive underlies even the standard textbook treatment of Giffen goods. Thus, as has been noted before (e.g., Gilley and Karels, 1991), the ideal place to search for Giffen behavior is among very poor households who consume only a few basic goods, with few substitution possibilities, and where one of the goods forms a large fraction of the total household budget. To this list we will add an additional requirement: the consumer cannot be so impoverished that he consumes *only* the staple good, since Giffen behavior is only possible if the consumer can finance additional expenditure of the staple good by reducing consumption of something else. With these conditions in mind, our analysis will focus on poor households in China surviving on less than the World Bank's extreme poverty line of a dollar per person per day, whose diet consists mostly of rice or wheat-based breads and noodles, meat when they can afford it, and some vegetables such as cabbage with very low caloric content.

One of the primary challenges in searching for evidence of Giffen behavior is finding sufficient and exogenous price variation for staple food items. Often, the variation in price for foods such as grains is limited since they are easily storable and transportable, and in some cases the prices are even directly set by governments. Even when sufficient price variation can be found, the underlying source of that variation might in fact be demand-related; higher demand

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implies that the commodity is normal, not inferior, and thus not Giffen at all. Thus economists looking for Giffen behavior at the level of the market are unlikely to find it.

leads to higher prices, which could be misinterpreted as Giffen behavior. In fact, estimating a demand elasticity from observations of market prices and quantities is the textbook example of an identification problem. In an earlier (unpublished) version of this paper (Jensen and Miller 2002) using panel data from the China Health and Nutrition Survey, we found suggestive evidence that poor households in China exhibited Giffen behavior with respect to their primary dietary staple (rice in the south, wheat and/or noodles in the north). However, because the study relied on possibly endogenous variation in market prices, we were unable to identify a causal relationship between price changes and consumption.[6] To address this concern, for the present study we conducted a field experiment in which for five months, randomly selected households were given vouchers that subsidized their purchases of their primary dietary staple. Building on the insights of our earlier analysis, we studied two provinces of China: Hunan in the south, where rice is the staple good, and Gansu in the north, where wheat is the staple.

Using consumption surveys gathered before, during and after the subsidy was imposed, we find strong evidence that poor households in Hunan exhibit Giffen behavior with respect to rice. That is, lowering the price of rice via the experimental subsidy caused households to reduce their demand for rice, and removing the subsidy had the opposite effect. This finding is robust to a range of alternative specifications and methods of parsing the data. In Gansu, the evidence is somewhat weaker, and relies to a greater extent on segregating households that are poor from those that are too poor or not poor enough. We attribute the relative weakness of the case for Giffen behavior in Gansu to the partial failure of two of the basic conditions under which Giffen behavior is expected; namely that the staple good have limited substitution possibilities, and that households are not so poor that they consume only staple foods. Focusing our analysis on those whom the theory identifies as most likely to exhibit Giffen behavior, we find stronger evidence of its existence.

The paper continues in Section II, where we explore a model that produces Giffen behavior through subsistence concerns. Section III presents the field experiment, the data, and our estimation strategy. Section IV presents the results, and Section V concludes.

[6] Rainfall is commonly suggested as an instrument for price. However, rainfall will be an invalid instrument for the price of a given food item since it likely also affects demand for the item by influencing both the prices of other

II. UNDERSTANDING GIFFEN BEHAVIOR

Traditionally, the possibility of Giffen behavior has been motivated by an argument similar to Marshall's (see p. 1). We will argue that the need to maintain subsistence consumption is the critical factor leading to Giffen behavior, drawing connections between Marshall's verbal argument, two mathematical models of the situation, and the graphical analysis found in microeconomics textbooks. Although much of what follows in this section has previously appeared elsewhere, we believe that this analysis provides a useful synthesis of theoretical approaches to the Giffen phenomenon.

II.A. The Characteristic-preference Model

We consider very poor consumers whose behavior is driven by the need to achieve a subsistence calorie intake. Following Lancaster (1966), rather than having preferences over the foods themselves, we model consumers as having preferences over two fundamental characteristics of foods: calories, c, and taste, t, where taste is meant to capture the non-nutritive aspects of food. For expositional ease, we assume there are only two foods, a basic good, b, such as rice, and a fancy good, f, such as meat. Let (c_b, t_b) and (c_f, t_f) denote the calories and taste provided by a unit of the basic and fancy goods, respectively. Let $p > 0$ denote the price of the basic good and normalize the price of the fancy good to 1. Spending one yuan (or Rmb, the Chinese unit of currency) on the fancy good provides more taste but fewer calories than spending a yuan on the basic good, i.e., $c_f < c_b / p$ and $t_f > t_b / p$.

The consumer's first priority is achieving subsistence calorie intake, which we denote by c^*. Once the consumer achieves subsistence, he attempts to maximize the taste of the foods he eats.[7] Since sufficiently impoverished consumers prioritize calories over taste, we begin by considering a consumer whose objective is to maximize taste subject to budget and subsistence constraints; later we allow for more general preferences. Let $w > 0$ be the consumer's wealth, and let b and f denote the units consumed of the basic and fancy goods, respectively. The consumer chooses b and f to maximize $t_b b + t_f f$ subject to the budget constraint, $c_b b + c_f f \geq c^*$, and the subsistence constraint, $pb + f \leq w$.

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foods and wages and income.

Figure 1 illustrates the consumer's problem. Each point in this 'characteristic space' is the calorie-taste outcome arising from a particular combination of the basic and fancy goods. Points F = ($c_f w$, $t_f w$) and B = ($c_b w/p$, $t_b w/p$) represent the calorie-taste bundles resulting from the consumer spending all their wealth on the fancy and basic goods, respectively. The set of affordable calorie-taste bundles is given by the convex hull of these two points and the origin, and the set of points where the consumer spends his entire wealth is the line segment FB. When the consumer's wealth is sufficiently high (i.e., point F lies beyond the subsistence constraint) as in Panel A, the consumer can afford to get his calories exclusively from the fancy good. The solution to the consumer's problem is in this case point F.

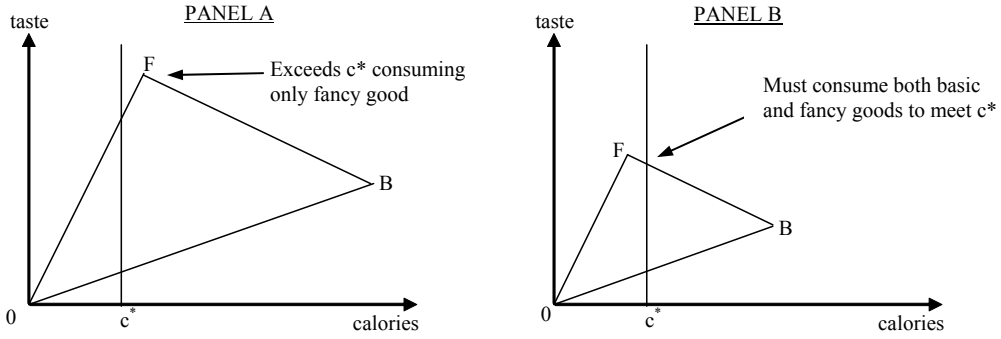

Figure 1: The consumer's problem with non-binding (Panel A) and binding (Panel B) calorie constraint.

If the consumer cannot achieve c^* calories by consuming only the fancy good (i.e., $c_f w < c^*$), as in Panel B, the solution to the consumer's problem lies at the intersection of the calorie constraint and the budget constraint FB. Thus, the consumer's demanded bundle is (b^*, f^*), where $b^* = (c^* - c_f w)/(c_b - c_f p)$ and $f^* = (w c_b - p c^*)/(c_b - c_f p)$. To see that the basic good is Giffen, note that $\partial b^*/\partial p = c_f (c^* - c_f w)/(c_f p - c_b)^2 > 0$. A price increase leads to increased consumption of the basic good. This can also be seen graphically in Figure 2. Here, we overlay vectors representing consumption of the basic and fancy goods; the slopes of these vectors reflect the calorie-taste combination for each good (they are therefore parallel to line segments 0F and 0B, which reflect choosing only the fancy and only the basic goods, respectively). Panel A shows the initial consumption choices for a consumer who is unable to achieve subsistence calories by consuming only the fancy good. Panel B depicts the impact of an increase in the price of the

[7] A more general constraint on minimum nutritional requirements behaves similarly.

basic good, which shifts the consumer's budget line from FB to FB'. Note that the vector *b'*, which depicts consumption of the basic good at the higher price, is longer than *b**, which depicts consumption at the original price. Thus an increase in the basic good's price increases its consumption, i.e., the consumer exhibits Giffen behavior.

In our simple model we have assumed that the consumer maximizes taste subject to a calorie constraint. However, the qualitative features remain unchanged for more general preferences, provided that utility increases in taste and the minimum calorie constraint binds, as it will for a sufficiently impoverished consumer.[8]

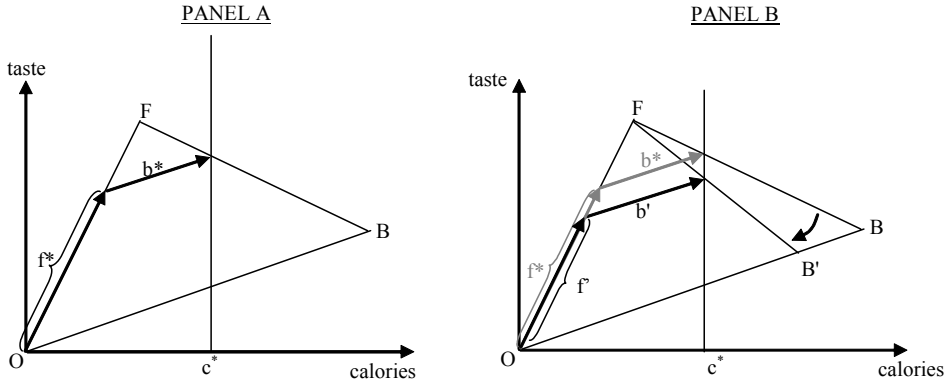

Figure 2: The response to a change in the price of the basic good (given a binding calorie constraint)

II.B. The Gilley – Karels Model

Gilley and Karels (1991) and Van Marrewijk and van Bergeijk (1990) study Giffen behavior in the context of the neoclassical model with an additional subsistence constraint. The consumer's utility maximization problem is to choose b and f to maximize u(b, f) subject to the same calorie and budget constraints as above, $c_b b + c_f f \geq c^*$ and $pb + f \leq w$, where u(b, f) is the consumer's utility function, assumed to be strictly increasing and strictly quasiconcave on all (b, f) that satisfy the subsistence constraint. All other notation is unchanged.

Our first task is to translate Figure 2 into the ordinary commodity space. Since $c_b/p > c_f$, the subsistence constraint is steeper than the budget constraint when b is plotted on the horizontal axis, as in Figure 3, Panel A. The set of feasible consumption bundles is the shaded area above

[8]The argument is essentially the same as the one presented at the end of Section II. B. Lipsey and Rosenbluth (1971) show in the context of the Lancaster (1966) model that Giffen behavior may be more likely than originally believed, even when the consumer is not subject to a minimum calorie constraint.

the subsistence constraint (dotted) and below the budget constraint (solid). Panel B depicts two possible budget sets for the consumer. In the first, the consumer has relatively high wealth w_1, and the consumer's subsistence constraint does not bind at the optimal consumption bundle, x_1. In this case, which is the standard case, the consumer's demanded bundle is the point of tangency between his utility isoquants and the budget constraint. However, as wealth decreases it becomes increasingly likely that the subsistence constraint binds at an optimum. In Panel B, wealth level w_0 corresponds to one such case. In this case, the highest utility bundle that satisfies both constraints lies on the intersection of the budget and subsistence constraints, just as it did in the characteristic-preference model. Thus the consumer demands bundle $x_0 = (b^*,f^*)$, where b^* and f^* are as in the previous section. Since the consumer's demand is the same as in the characteristic-preference version of the problem, once again the basic good is Giffen.

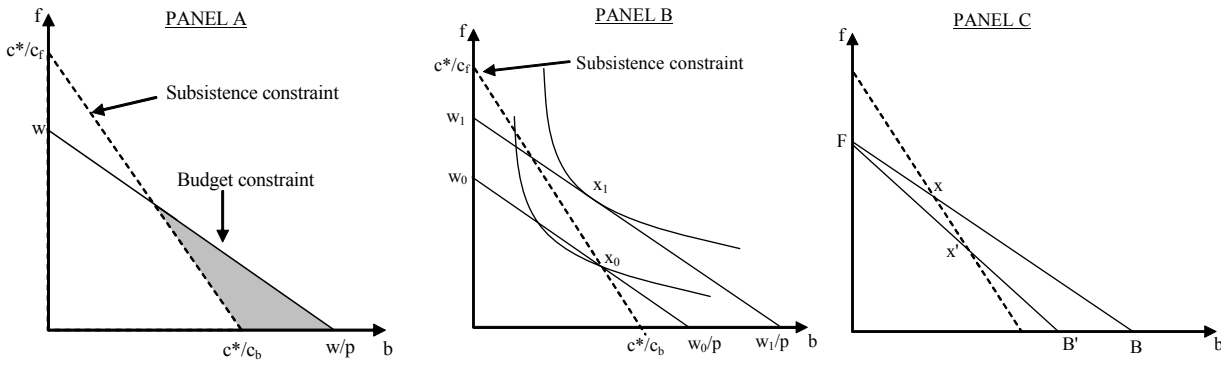

Figure 3: Giffen Behavior in the Gilley-Karels Model.

To see the consumer's reaction to a price increase graphically, consider Panel C, which presents the price increase from p to p' shown in Panel B of Figure 2. At price p, the budget constraint is line FB, where F = (0, w) and B = (w/p, 0), and the consumer demands bundle x. The price increase to p' pivots the budget constraint clockwise to line FB' (B' = (w/p', 0)) and moves the intersection of the budget and subsistence constraints to point x'. Whichever bundle the consumer demands, it must lay on the new budget line between points x' and B'. However, any such point involves consuming more of the basic good, i.e., Giffen behavior.

II.C. The Graphical (Textbook) Approach

Approaches such as those presented above have been criticized on the grounds that consumer theory posits consumers who maximize preferences subject to a budget constraint.

Any need for subsistence should therefore be built into the consumer's preferences (Wichers 1994). In this section we present the textbook explanation of the Giffen phenomenon and argue that implicit in the shape of the indifference curves needed to account for Giffen behavior is a subsistence motive.

The standard pedagogical tool of intermediate microeconomics for explaining the Giffen phenomenon involves a graphical explanation. However, the indifference map needed to induce Giffen behavior is not standard. For example, typical, Cobb-Douglas indifference curves cannot generate Giffen behavior. In the typical presentation, the indifference curves used to illustrate Giffen behavior appear to "fan out," becoming closer together as you move to the northwest, as depicted in Figure 4, Panel A, where demand for the basic good increases as the price of the basic good increases.[9]

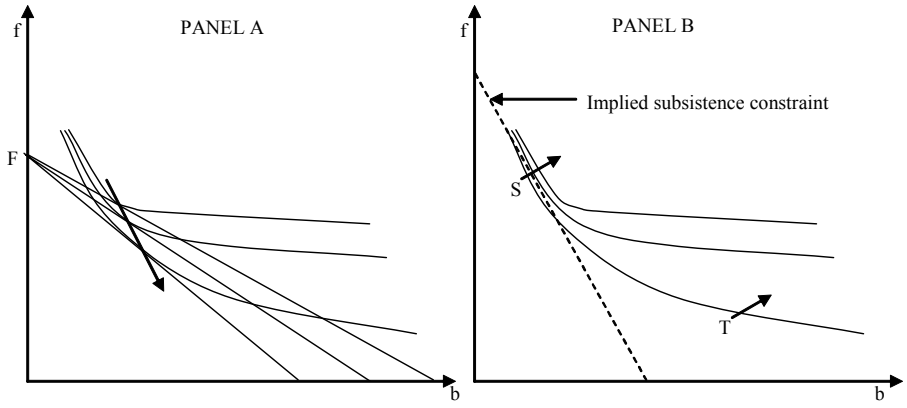

Figure 4: The Textbook Approach to Giffen Behavior

The link between the graphical presentation and the subsistence-constraint models is found in the shape of the indifference curves used to induce Giffen behavior. Consider Figure 4, Panel B, which isolates the indifference curves from Panel A. Notice that because of the shape of the indifference curves, the consumer's utility increases more steeply when moving perpendicular to the dotted line than when moving parallel to it, and that utility also increases more steeply near the dotted line (point S) than above it (point T). Because utility increases rapidly perpendicular to the dotted line, the consumer will behave as if he faces a constraint to choose, whenever possible, a consumption bundle laying to the northeast of this line. It is, in

[9] Spiegel (1994) constructs a utility function that leads to Giffen behavior whose isoquants exhibit this shape.

effect, an implied subsistence constraint; thus the subsistence motive underlies even the standard pedagogical treatment of the Giffen phenomenon.

Thus, despite ostensibly different approaches, the intuition underlying all four motivations for Giffen behavior is the same. Poor consumers with few substitution possibilities facing a real or implied subsistence constraint will be forced, following an increase in the price of a basic good, to consume more of the cheapest source of calories available and less of other goods. As Gilley and Karels (1991, p.181) note, this suggests that "the most likely place [to find Giffen behavior] would be among the very poor, consuming a few staples, with limited substitution possibilities."

While these factors make detecting Giffen behavior more likely, there is one additional factor that must be considered. The mechanics of substitution accompanying Giffen behavior involve the consumer decreasing consumption of more desirable foods such as meat in order to increase consumption of the staple. However, extremely impoverished consumers may be so poor that they cannot afford to consume any of the fancy good. In this case, even if the price of the basic good goes up, Giffen behavior is not possible since there is no good whose consumption can be reduced to fund increased purchases of the basic good. Thus, while consumers must be poor, they cannot be too poor.

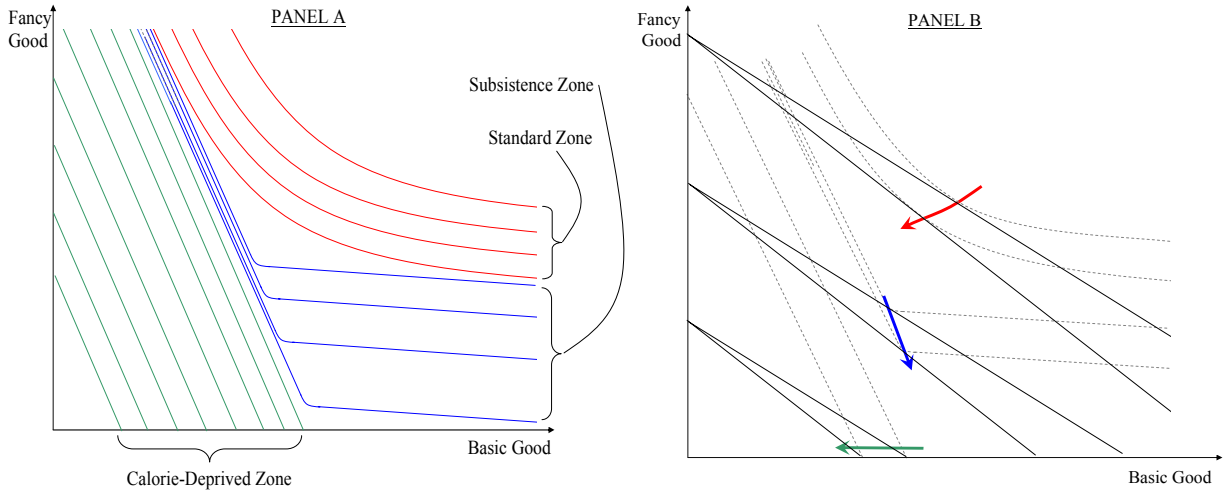

Figure 5. The Different Zones of Consumer Preferences

In light of this, the consumer's preferences can be thought of as falling into three distinct zones, as illustrated in Figure 5. In panel A, the outer set of indifference curves correspond to the

standard case, where the consumer's calorie intake is well above subsistence. Over this range the consumer trades off between calories and taste (and thus between the basic and fancy goods) in an ordinary way, and thus in panel B they respond to an increase in the price of the basic good by decreasing consumption of that good. The middle group of indifference curves corresponds to the range of consumption bundles over which the consumer crosses from malnutrition into nutritional stability. Over this range, the consumer is willing to sacrifice a great deal of taste (and thus the fancy good) in order to maintain calories; thus in panel B, they respond to an increase in the price of the basic good by consuming more of it, i.e., they exhibit Giffen behavior. Finally, in the inner-most, calorie-deprived zone, the consumer is struggling to achieve subsistence calorie intake, and therefore values increases in calories almost exclusively. Further, they may be using their entire budget on only the basic good, and thus as seen in Panel B, they have no choice but to respond to a staple price increase by consuming less of it.

This analysis points to several additional considerations in the search for Giffen behavior. First, as we have been stressing, being "Giffen" is not a property of a good, but rather the property of a particular consumer or set of consumers at a particular time, i.e., at particular price-wealth vectors. Second, when focusing on the very poor, we might expect that consumers will pass through a Giffen zone. The moderately impoverished will exhibit Giffen behavior, but those who are so poor that they do not consume the fancy good will not. Finally, because Giffen behavior is to be expected from a relatively small group of consumers, we should focus our attention on this group rather than on market level analyses. A subset of consumers might exhibit Giffen behavior with respect to a particular commodity while the overall market exhibits downward sloping demand.

Poor Chinese consumers fit nicely with the assumptions of the model. The crucial feature leading to Giffen behavior is the presence of one predominant cheap source of calories, i.e., a single basic good. In our sample, the basic good is rice (in the south) or wheat (in the north), and the fancy good is pork and other meat. While other foods such as vegetables are consumed, they provide far fewer calories per yuan than staple grains, and therefore do not serve as basic goods; the intuition of the model easily extends to include foods such as this.

III. EMPIRICAL STRATEGY

III. A. The Experiment

A central problem in searching for Giffen behavior, and indeed in any analysis of demand, is finding both sufficient and exogenous price variation. As a practical problem, whether data are cross-sectional, time-series or panel, there is often not a great deal of variation in prices for the kinds of goods likely to be candidates for Giffen behavior. This applies especially to cross-sectional data, as arbitrage should eliminate spatial price differences, especially for easily storable and non-perishable commodities such as grains.[10] And any remaining price variation may be due do unobservable quality differences. Beyond this, a more serious concern is that even with sufficient price variation, the source of that variation is often potentially endogenous, since price is the equilibrium of a system of simultaneous equations. A positive correlation between price and consumption could simply represent shocks to, or differences in, demand over space or time rather than Giffen behavior. Although instrumental variables could address this problem, finding instruments that shift supply but do not directly affect demand is difficult.[11]

To overcome these challenges, we conducted a field experiment in which we provided randomly selected poor households in two Chinese provinces with price subsidies for staple foods. In Hunan, a southern province, rice is the staple good, and in Gansu, a northwestern province, wheat is the staple good (consumed primarily as buns, a simple bread called *mo* or noodles). These regional 'taste' differences are primarily determined by geography, climate and history, with wheat the dominant crop grown in Gansu and rice dominant in Hunan.[12] Accordingly, we subsidized rice (only) in Hunan and wheat flour (only) in Gansu.

Within each sample cluster (described below), households were randomly assigned to either a control group or one of three treatment groups. Households in the treatment groups were

[10] Further, for extremely poor consumers, the prices for staple goods might even be fixed by the government for the poorest households, such as under India's Public Distribution System.

[11] Most previous studies of Giffen behavior have failed to address the identification concern. The few cases that have relied on instrumental variables have used problematic instruments. For example, Bopp (1983) uses refinery utilization rates and the price of crude oil as instruments for the price of kerosene; however, both instruments likely also affect the price of substitute fuels, and are likely to be driven by other unobserved factors also affecting fuel demand, such as weather. Baruch and Kannai (2001) use the lagged prime interest rate as an instrument for the price of a low-grade Japanese alcohol (*shochu*), which is likely be a poor predictor of the price of *shochu*, or, to the extent that it does predict the price, will likely also affect the prices of substitutes (or income – and thus demand).

given printed vouchers entitling them to a price reduction of 0.10, 0.20 or 0.30 yuan (1 Rmb ≈$.12-.13) off the price of each *jin* (1 *jin* = 500g) of the staple good (the subsidy level stayed fixed for each household over the course of the study). These subsidies represented substantial price changes, since the average pre-intervention price of rice in Hunan was 1.2 yuan/*jin*, and the average for wheat flour in Gansu was 1.04 yuan/*jin*. The vouchers were printed in quantities of 1, 5 and 10 *jin*, and the month's supply of vouchers was distributed at the start of each month, with each household receiving vouchers for 750g per person per day (about twice the average per capita consumption). All vouchers remained valid until the end of the intervention. Households were told in advance they would receive vouchers for five months and that any un-redeemed vouchers would not be honored afterwards.

The vouchers could be redeemed at local grain shops. The merchants in these shops agreed to honor the vouchers in exchange for reimbursement and a payment for their participation. Households and merchants were told they were not permitted to exchange the vouchers for anything but the staple good, that there would be periodic auditing and accounting to make sure they were in compliance with the rules, and that any violations would result in them being removed from the study without any additional compensation. Households and merchants were explicitly told that selling the vouchers for cash or reselling rice or wheat bought with the vouchers would result in dismissal from the program.

There are several points about the intervention worth noting. First, all foods in China are sold in free markets, at market determined prices. A 1993 reform of the grain distribution system largely put an end to price controls, state food stores, or free rations. Second, the number of subsidized households in each sample site is trivial relative to the size of the population (all sites were county seats, most with populations over one million), so the intervention could not have affected market prices. Third, the experiment is predicated on the assumption that either households are limited in their ability to borrow and save, or they have short planning horizons; otherwise, the wealth effect of the five-month subsidy would be trivial, making Giffen behavior unlikely. Though to the extent the wealth effect of the price change can be smoothed over the lifetime, this will bias us against finding Giffen behavior. Fourth, limiting the quantity of vouchers to 750g/person/day might limit the potential demand response for the staple good

[12] Though the difference in staples is often regarded as arising from taste, differences in price (due in part to transportation costs) likely play a role as well. For example, in Hunan one *jin* of rice costs 1.24 yuan and one *jin* of

(though the amount is still quite generous), but it should not induce Giffen behavior, as might be the case (though still unlikely) if we limited the vouchers to a quantity smaller than what they would prefer to consume.[13] Finally, while staple foods such as rice can be found in varying qualities or varieties with different prices, because the households in our sample are extremely poor, our data show that they consume almost exclusively only the lowest-cost variety. Therefore, quality substitution in response to the price subsidy is not a concern for our analysis. Two final concerns with the experiment, namely whether there was cheating (in the form of cashing out or reselling) or whether the vouchers might create a 'salience' effect, are discussed with the results in section IV.E.

III.B. The Data

The survey and intervention were conducted by employees of the provincial level agencies of the Chinese National Bureau of Statistics. The sample consisted of 100-150 households in each of 11 county seats spread over Hunan and Gansu Provinces (Anren, Baoqing, Longshan, Pingjiang, Shimen and Taojiang in Hunan, and Anding, Ganzhou, Kongdong, Qingzhou and Yuzhong in Gansu), for a total of 1,300 households (650 in each province), with 3,661 individuals. Within each county, households were chosen at random from lists of the 'urban poor' maintained by the local offices of the Ministry of Civil Affairs.[14] Households on this list fall below a locally-defined poverty threshold (the *Di Bao* line), typically between 100 and 200 yuan per person per month or $.41-$.82 per person per day, which is below even the World Bank's 'extreme' poverty line of one dollar per person per day.

The questionnaire consisted of a standard income and expenditure survey, gathering information on the demographic characteristics of household members as well as data on employment, income, asset ownership and expenditures. A key component of the survey was a 24-hour food recall diary completed by each household member. Respondents were asked to report everything they ate and drank the previous day, whether inside or outside the home, by

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wheat flour costs 1.41 yuan, whereas in Gansu the prices are 1.77 and 1.04 yuan, respectively.

[13] One concern is that by limiting the potential increase in consumption in response to the price decline, we might skew the average consumption change towards a decline (i.e., Giffen behavior). However, in practice almost no households even approached the voucher limit, most likely due to their extremely low incomes and a lack of access to credit, so this is unlikely to be a major concern.

[14] We chose urban areas because in smaller towns or rural areas many of the poorest households grew rather than purchased their staple food, and lower population density meant fewer households living in extreme poverty, which would have both required a greater number of sample clusters and prevented varying the treatment within clusters.

specifically listing the components of all foods eaten.[15] These foods were recorded in detail in order to match with the 636 detailed food items listed in the 1991 Food Composition Tables constructed by the Institute of Nutrition and Food Hygiene at the Chinese Academy of Preventative Medicine. Though as we will see below, because households are very poor, most diets are very simple and consist of a small number of basic (non -processed, -prepared or -packaged) foods like rice, bean curd or stir-fried cabbage, so concerns about coding the specific quantities of the various ingredients in a complex dish or meal are not significant.[16]

Data were gathered in three waves, conducted in April, September and December of 2006. After completing the first survey, treatment households were told they would receive the subsidies for five months, from June through October. Thus, the initial interviews occurred before treatment households knew of or received the subsidies, the second occurred after the subsidy had been in place for slightly more than 3 months, and the final interviews were conducted 1 to 2 months after the subsidy had ended, by which time treatment households would likely have exhausted any stocks of rice they may have purchased with the subsidy, and will therefore again be purchasing at the full market price. Attrition was extremely low, since the three rounds occurred in a relatively short span. Only 11 of 1,300 households (<1%) in the first round did not appear in the second round. All households in the second round were interviewed in the third round. Means and standard deviations for key variables are presented in table 1.[17]

Table 2 shows the basic characteristics and prices of foods in Hunan and Gansu. The data are for the most commonly consumed, representative foods within a category;[18] information on calories and protein are obtained by merging with the 1991 Food Composition Tables. The table shows that, consistent with their respective roles as staple foods, the cheapest source of calories in Hunan is rice (1399 calories per yuan), while in Gansu it is wheat (1655 calories per yuan). These foods are a cheaper source of calories than even the least expensive alternative grain,

[15] While it may seem difficult to recall or estimate how many grams of, say, rice was eaten with a meal, for the extreme poor who are on a very limited budget, food is often apportioned and accounted for much more carefully. Further, diets for these extremely poor households often vary little or not at all from day-to-day, except on special occasions, so recalling the quantity of specific food items is not as difficult.

[16] Similarly, because households were so poor, almost all food (98 percent) was at-home consumption, so respondents were aware of the exact ingredients and quantities used.

[17] While there are some differences in variables across control and treatment groups, these arise largely due to random variation given the relatively small sample size. Randomization was done blindly by the authors, rather than the field teams, so any differences should not be systematic. Further, any differences in variables across households based on treatment assignment will be eliminated because our analysis uses household fixed effects.

millet. By contrast, if we view fat as a crude measure of taste, pork provides the most taste per yuan. While rice and wheat appear to be inexpensive sources of protein as well, these nutritional data are somewhat misleading; lacking a few essential amino acids, these grains only provide protein when combined with the amino acids found in other foods, such as pulses (and vice-versa for pulses, which do not provide complete proteins unless combined with grains). Given that households are already consuming a large amount of rice or wheat, pulses are a less expensive source of protein than pork. However, they provide significantly less fat or taste per yuan. Finally, cabbage is the least expensive food per kilogram in both provinces, but it provides very few calories (or amino acids for creating protein), and thus is not a substitute for rice or wheat.

Table 3 shows the basic consumption patterns for households in the two provinces. The dominance of (and difference in) staple goods in the two regions is evident. In Hunan, the average per capita consumption of rice per day is 330g, comprising 64 percent of daily caloric intake. The dominance of rice consumption is widespread in Hunan; the 25th percentile of the distribution of rice calorie share is 52 percent, the 75th percentile is 78 percent, and the coefficient of variation (standard deviation divided by the mean) is extremely low at only 38 percent. The consumption of wheat is low in Hunan, with only 42g of daily consumption per person on average, comprising just 8 percent of total caloric intake. By contrast, Gansu features almost the exact reverse pattern; wheat-based foods are the dominant staple, with 344g of consumption per person per day, comprising 69 percent of total calories, whereas rice consumption is only 35g. And as in Hunan, the dominance of consumption of the staple is widespread; the 25th percentile of the distribution of calorie share from wheat is 60 percent, the 75th percentile is 80 percent, and the coefficient of variation is just 39 percent. Thus in both provinces, the relevant staple good is a dominant source of calories for most households. The total calorie share from all cereals or grains is 72 percent in Hunan and 77 percent in Gansu. The reliance on these basic foods for nutrition is underscored even more by the fact that in both provinces, on average 13 percent of calories come from edible oils (mostly vegetable oil), which is primarily used in cooking (and is generally not a substitute for other forms of consumption or nutrition). Thus, the consumption of all other foods combined on average contributes only 10 percent of calories in Gansu, and 15 percent in Hunan.

[18] Rice: late, long-grain (*wanxian*); wheat: standard (*Biaozhunfen*); bean curd (*nandoufu*); cabbage (*Dabaicai* (*xiaobaikou*)); pork: lean and fatty (*Zhurou* (*feishou*)); Millet: foxtail (*xioami*); eggs: hen eggs (*jidan*).

In both provinces, vegetables and fruit (predominantly cabbage in Hunan, and cabbage and potatoes in Gansu) are the second largest category of consumption based purely on quantity or bulk. Though overall, they contribute little to caloric intake (5 percent in Hunan and 7 percent in Gansu) due to the very low caloric value per gram of these foods. The remaining consumption of meat (primarily pork), pulses (primarily bean curd or tofu) and dairy (primarily milk) constitute about 10 percent of calories in Hunan and 4 percent in Gansu. In Hunan, the greatest share comes from meat, with 42 grams of consumption per person per day on average, comprising 7 percent of average caloric intake. By contrast, in Gansu meat consumption is significantly lower, averaging only 13 grams per person per day and contributing less than 1 percent of total caloric intake. Consumption of pulses is in fact greater than consumption of meat in Gansu. This is likely due to the lower levels of income in Gansu; pulses are often referred to as 'poor man's meat' because they are a cheaper source of protein (again, when combined with other foods typically eaten as staples). Therefore, while the consumption patterns in Hunan match up well with the basic set-up under which we predict Giffen behavior, in Gansu the patterns do not fit quite as well due to relatively low meat consumption.

III. C. Estimation Strategy

Given the random assignment of the price change and the panel nature of our survey, our basic strategy is to simply compare the household-level changes in dietary intake[19] of the staple good for treatment and control groups. Since assignment to treatment and control groups was randomized within sample counties, we add county*time fixed effects, so that we are in effect comparing the changes for households with different subsidy levels within the same community. This strategy controls for any county-level factors that change over time, such as the prices of foods, labor market conditions or the value of government transfer programs.

We regress the percent change in intake of the staple good for household i in period t on the change in the subsidy (in percent). The percent change formulation normalizes for factors such as household size, composition, and activity level and allows us to interpret the coefficients as elasticities. For each household, we observe two changes: the change between periods 2 and 1

[19] While we also gathered data on food purchases and expenditures, actual daily intake is likely to be a better measure of consumption or demand than purchases or expenditure. This is due to the fact that food is storable, purchases are lumpy, and households' recollection of food consumption from the day before the survey is likely to be significantly more accurate than recollections of purchases or expenditures over the last month.

($t = 2$), capturing the effect of imposing the subsidy, and the change between periods 3 and 2 ($t = 3$), capturing the effect of removing the subsidy. Thus we estimate:

$$\%\Delta staple_{i,t} = \alpha + \beta \%\Delta p_{i,t} + \sum \gamma \%\Delta Z_{i,t} + \sum \delta County * Time_{i,t} + \Delta \varepsilon_{i,t} \quad (1)$$

where $\%\Delta staple_{i,t}$ is the percent change in household i's consumption of the staple good, $\%\Delta p_{i,t}$ is the percent change in the price of the staple due to the subsidy (negative for $t = 2$ and positive for $t = 3$), $\%\Delta Z$ is a vector of percent changes in other control variables including income (split into earned and unearned (government payments, pensions, remittances, rent and interest from assets) sources) and household size, and *County*Time* denotes a set of county*time dummy variables. We compute all changes as arc-percent-changes (i.e., $100*(x_t - x_{t-1})/((x_t+x_{t-1})/2)$). The percent change in the subsidy is computed as 100 times the change in the subsidy divided by the average (net of subsidy) price of the staple good in the two corresponding rounds. The results are virtually unchanged if we use the percent-change in the unsubsidized prices. The results are robust to a wide range of alternative specifications, some of which we discuss in section IV.B.

III. D. Refining the Test for Giffen Behavior

The theory predicts that only households that are poor, but not too poor, will exhibit Giffen behavior. Thus we would like to focus our study on households that are in the subsistence range, but not below it, or above it. Unfortunately, classifying households or individuals directly in this way is not possible. Not only is there no consensus on what constitutes a subsistence level of calories, but any such threshold would certainly vary widely by age, sex, height, weight, body fat and muscle composition, level of physical activity, health status and a range of other factors. As a result, although we can compute caloric intake for each individual, identifying whether specific individuals are below, near or above their subsistence level of caloric requirements is not possible. For the same reason, it isn't possible to define these regions based on income or expenditure; individuals with different characteristics will require different amounts of expenditures or income to achieve nutritional sufficiency. Any such cut-offs would be imperfect, including some people who, because of high weight or activity levels, are unable to achieve maintenance nutrition with the specified income, and excluding others who have lower than expected nutritional (and thus income) needs because of small stature or low activity levels.

The method of parsing the data we employ is based in the theory. Those who are so poor that they cannot achieve maintenance nutrition will consume a very high proportion of their food

in the form of the staple good, regardless of size and activity level. Thus, splitting the data by the pre-intervention or initial share of caloric intake from consumption of the staple (initial staple calorie share, ISCS) provides a more direct measure of whether a consumer or household is well-off enough that they could, potentially, exhibit Giffen behavior. This idea is illustrated in Figure 6, which revisits the response to an increase in the staple price for households in the different consumption zones, as in Figure 5. When the household or individual is so poor that they are at very low levels of caloric intake relative to subsistence need they will have a very high share of calories from the staple good; in this range, they respond to a staple price increase by decreasing consumption of that staple. As they become wealthier and move into the subsistence zone, the staple calorie share decreases, and in this range, they exhibit Giffen behavior. Finally, at even higher levels of wealth, they move into the normal consumption zone with downward sloping demand. Thus, in our test for Giffen behavior, we will want to segregate those households with the very highest levels of ISCS.

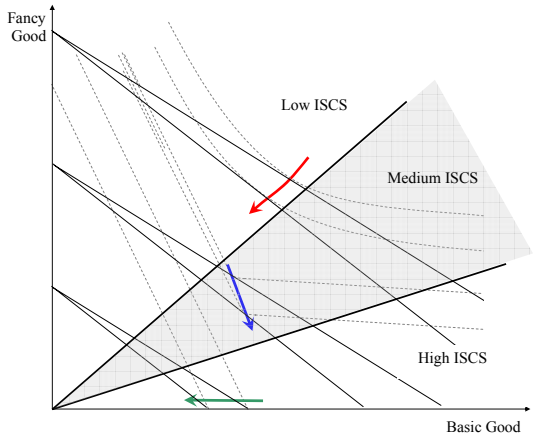

Figure 6. Consumption Path and The Staple Calorie Share

While just using ISCS does not overcome the problem of identifying the exact threshold cut-off for moving from the calorie-deprived to subsistence zones, the advantage of this measure is that it is more 'need neutral,' in that it normalizes for individual differences in caloric requirements. The measure also captures the simpler idea that if a household is so poor that it does not consume any of the fancy good, it cannot respond to a price increase by consuming less of it. While ISCS may not be a perfect indicator of whether a household is near the subsistence zone (because of unobserved taste variation, for example), we believe it to be superior to other

available measures. As a robustness check, we will also use expenditure-based measures to parse the data, although, as expected, these seem less able to isolate the poor-but-not-too-poor.

Exploratory calculations using a simplified version of a minimum-cost diet problem[20] for China suggest that the ISCS associated with a minimum-cost, nutritionally-sound diet (designed to ensure adequate consumption of calories and protein, and consisting of rice or wheat and bean curd) is much less variable than either required calories or required expenditure (details provided in the appendix). We compute the minimum cost diet for a range of weight/age/gender/activity level combinations, and find that the ISCS associated with the minimum-cost, nutritionally-sound diet only ranges between 79% and 86% in Hunan and 78% - 85% in Gansu. Consumers or households that are wealthy enough to be consuming a diet with a lower ISCS would seem to be those who could, in principle, exhibit Giffen behavior. In light of this, our baseline specification splits households based on whether their ISCS is less than 0.8 (this corresponds approximately to the 80th percentile of the staple calorie share distribution). However, we also explore the robustness of the results to different thresholds.

While the theory suggests we should also exclude the wealthier households in the standard zone of consumption, unlike the threshold for segregating households that are too poor, it is unfortunately not possible to estimate the threshold for this region. Further, because our sample is drawn from the poorest households, there is no guarantee we even have any households in this zone. Therefore we begin by taking the conservative approach of only using the threshold excluding the poorest; if our theory is correct, if anything keeping the lower tail of the staple calorie share distribution will make it less likely we find Giffen behavior, since we are potentially including households with downward sloping demand among our potential Giffen consumers (we explore this possibility in section IV.C).

IV. RESULTS

IV. A. Hunan

The estimation results for equation (1) for Hunan are presented in table 4 (standard errors clustered at the household level). Starting with the full sample of households in column 1, a 1 percent increase in the price of rice causes a .24 percent increase in rice consumption (i.e.,

[20] See, for example, Dorfman, Samuelson and Solow (1958).

consumption declines when the subsidy is added, and increases when it is removed).[21] While the coefficient is only statistically significant at the 10 percent level, it provides our first evidence of Giffen behavior in Hunan. And as would be expected for households exhibiting Giffen behavior, the income effect is negative for unearned income, confirming that rice is an inferior good. The point estimate of the elasticity of unearned income is small, though there is likely to be significant measurement error in this variable, biasing the coefficient towards zero.[22]

In columns 2 and 3, we refine the test for Giffen behavior by parsing the data according to the theory, separating households by whether their pre-intervention staple calorie share suggests they are likely to be too poor to purchase something other than rice. For the group consuming at least some substantial share of calories from sources other than rice (column 2), i.e., the poor-but-not-too-poor, we find very strong evidence of Giffen behavior. A one percent price increase causes a .47 percent increase in consumption, and the effect is statistically significant at the 1 percent level. Thus, as theorized by Marshall and others, when faced with an increase in the price of the staple good, these households do, indeed, appear to "consume more, and not less, of it (Marshall, 1895)."

By contrast, but again consistent with the theory, the group consuming more than 80 percent of their total calories from rice (i.e., those still largely unable to consume meat), respond in the opposite direction (column 3), with a large decline in rice consumption. Since these households consume essentially only rice, they have no choice but to respond to an increase in the price of rice by reducing demand. Thus, beyond finding evidence of Giffen behavior, the results also provide initial support for the subsistence model underlying such behavior. We find Giffen behavior where the model predicts it, and downward sloping demand elsewhere. We explore the subsistence model further in section IV.C.

IV. B. Robustness

The finding of Giffen behavior is robust to a wide range of alternate specifications, shown in table 5. Columns 1 to 3 present regressions of the change in the log of household rice

[21] Although our intervention caused a price decrease between rounds 1 and 2 and a corresponding increase between rounds 2 and 3, for ease of exposition and interpretation we will typically refer to the effects of a price increase, the more traditional and intuitive way of describing Giffen behavior.

[22] The coefficient on earned income is positive (though also small); however, since greater caloric intake may improve productivity and earnings (Thomas and Strauss, 1997), especially among those with very low nutritional

consumption on the change in the log of the net-of-subsidy price of rice (instead of arc percent changes) and changes in logs of the other control variables. The results again reveal Giffen behavior for households consuming less than 80 percent of their calories from rice, and downward sloping demand for those above this threshold. The point estimates of the elasticities are much greater here than for the arc percent changes in table 4. However, this difference is largely attributable to the greater weight given to very low values with a log specification; for example, if we trim just the lowest 1 percent of rice consumers in Hunan, the coefficients are almost identical to those in table 4 (.229 (.183), .461 (.218) and -.558 (.250) for the full sample and the less than and greater than 80 percent staple calorie share groups, respectively). Returning to our main specification (equation 1) but using the arc percent change in rice consumption per capita (rather than total household consumption) as the dependent variable (columns 4 – 6) or the percent change in consumption using individual-level data (adults only; columns 7 – 9) again reveals Giffen behavior for the group with less than 80 percent calorie share (though the results for those with greater than 80 percent, while negative, are no longer statistically significant).

To explore the robustness of the conclusions to an alternative way of classifying households into consumption zones, columns 10 – 13 return to equation (1) but split households by pre-intervention expenditure per capita.[23] As described earlier, due to variations in individual and household characteristics, we believe expenditure to be an inferior method of classifying consumers into different consumption zones. Nevertheless, doing so provides a useful robustness check. Lacking in this case a threshold based on a cost minimization problem, we simply stratify households based on whether they are above or below the 15th or 25th percentile of the expenditure distribution. We again see evidence of Giffen behavior among the poor-but-not-too-poor. Those above the bottom quartile (column 10) respond to a one percent increase in the price of rice by increasing rice consumption by .29 percent, though the effect is statistically significant at only the 10 percent level. And unlike the case of stratifying by staple calorie share, the poor group in this case does not decrease consumption in response to a price increase; this is likely due to the relative imprecision of relying on the expenditure-based threshold. Using the 15th

status, this coefficient may be biased due to endogeneity. Unfortunately, we lack convincing instruments for changes in earned income. Dropping this variable does not change the results.

[23] Ideally, we would use the data from each particular round to assess living standards rather than using only the pre-intervention data, since Giffen behavior depends on a consumer's budget at the time they make their decisions. However, expenditure in the round with the subsidy is obviously endogenous with respect to the subsidy; income would encounter enodgeneity as well (the increased consumption afforded by the subsidy might affect earnings).

percentile cut-off, we see strong evidence of Giffen behavior for the poor-but-not-too-poor, and now the coefficient for the poorest is negative, though it is not statistically significant.

As a final robustness check, since the 80 percent threshold for the rice calorie share was a rough approximation based on a minimum-cost diet, table 6 shows the original regressions using alternative thresholds. As the threshold varies from 70 to 90 percent, the point estimate of the elasticity for those below the threshold varies only from .27 to .47, with statistically significant coefficients in all cases. Therefore, the results point convincingly and robustly to the conclusion of Giffen behavior in Hunan. Additionally, as might be expected from the subsistence model, the coefficients broadly increase as the staple calorie share threshold declines from .90 to .75, as we are in effect excluding more and more of the least well-off, i.e., those most likely to respond to a price increase by decreasing consumption. The coefficients for each corresponding group above the threshold staple calorie share are negative for all thresholds up to .70; however, due in part to the smaller sample sizes in some of the cases, the effects are only statistically significant at the 10 percent level or better for the 75, 80 and 85 percent thresholds. The increase in the coefficients as the threshold moves from .85 to .70 is consistent with increasingly including some of the least poor of the poor who are in the subsistence rather than the calorie-deprived zone, for whom the response to a price increase is positive.

Thus, overall, across a range of specifications, alternative thresholds and ways of classifying households into consumption zones, the results point to robust evidence of Giffen behavior with respect to rice in Hunan.[24]

IV. C. Exploring the Subsistence Model and Refining the Giffen Zone

While the main goal of our study is to document Giffen behavior, we briefly explore a few implications of the subsistence model. We have already seen that consumers with very high staple calorie shares do not exhibit Giffen behavior. In addition, the model also predicts that once consumers are wealthy enough to pass beyond the subsistence zone into the standard consumption zone, staple demand should once again slope downward; in effect, we predict an 'inverted-U' shape, with downward sloping demand (negative coefficients) for low and high

[24] We also find Giffen behavior separately for male and female headed households, though the threshold at which the effects are statistically significant is lower for male headed households. In order to focus the present analysis on the Giffen hypothesis, the link between gender, intrahousehold allocation and the demand for nutritional status is further explored in a companion paper (Jensen and Miller 2007).

values of staple calorie share, and Giffen behavior (positive coefficients) for intermediate values.[25] As stated, unlike the 80 percent calorie share, it isn't possible to define a threshold beyond which households are likely to be in the standard or normal consumption zone, nor are we even certain our sample of the urban poor contains any such households. We therefore take a simple, flexible approach using a series of locally weighted regressions. At each staple calorie share point from .30 to .95 (there are few observations below .30 or above .95), we estimate equation (1) using a window of staple calorie shares of .10 on either side of that point; within that window we estimate a weighted regression, where observations closest to the central point receive the most weight (we use a biweight kernel, though the results are robust to alternatives). Figure 7 plots the resulting coefficients on the arc percent price change variable at each staple calorie share point for Hunan, along with the associated 95 percent confidence interval. The basic inverted-U shape in staple calorie share is clear. The coefficient is negative for the lowest and highest staple calorie shares, and positive in between. The Giffen range, where the point estimate of the elasticity is positive, reaches from .53 to .84, though it is only statistically significant from .63 to .75. The peak of the curve reaches an elasticity of .85, at a staple calorie share of .70. And the threshold at which the elasticity turns negative is .80, which corresponds well to our simple minimum cost diet calculation. In general, the precision of these estimates is lower than those observed in tables 4 − 6, since here we are restricting each regression to a band of ±.10 around a particular point, which reduces the sample size.

Not only does this figure support the theory in that Giffen behavior is most likely to be found among a range of households that are poor, but not too poor or too rich, it also guides us to a particular range when theory can't provide a specific set of thresholds, as with the threshold between the subsistence and normal consumption zones. In particular, this curve suggests we restrict the range in which we test for Giffen behavior not just to those with a staple calorie share less than .80, but also to those with at least, say, .60. In column 4 of Table 4, doing so increases the point estimate of the elasticity dramatically, from .46 to .73, as we are in effect removing the wealthiest households.[26] And even with the smaller sample, the effect is statistically significant at the one percent level, again strongly supporting the conclusion of Giffen behavior in Hunan.

[25] Though, if we do not have enough households wealthy enough to fall into the normal consumption zone, we expect that the coefficients should at least decline as staple calorie share declines.

[26] This coefficient differs slightly than the peak coefficient in figure 7 since the latter arises from a weighted regression, with more weight assigned to the points closer to the peak of the curve.

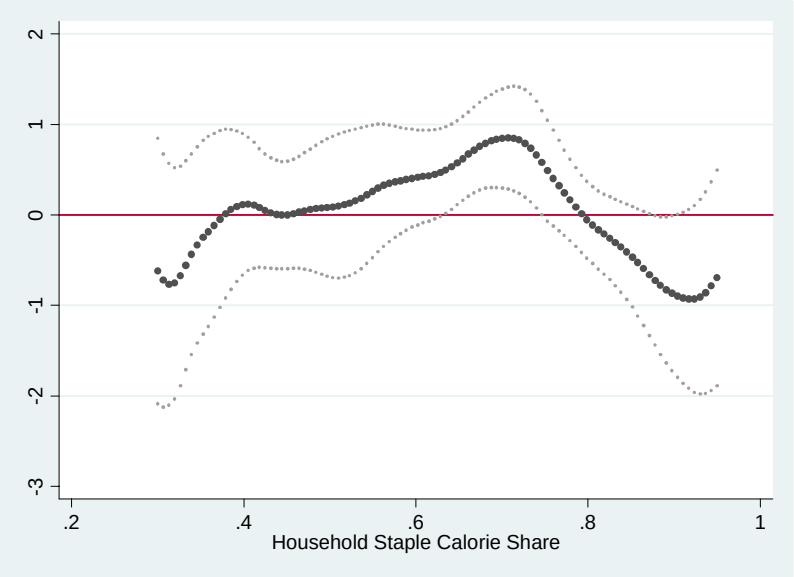

Figure 7. Coefficient Plot for Hunan

A second prediction of the subsistence model we can explore is that in response to an increase in the price of the staple good, consumers facing a subsistence constraint will not only consume more of the basic good, but will also consume less of the fancy good, which we identified here as meat. Column 5 of table 4 shows regressions like (1) above, but using the arc percent change in meat consumption as the dependent variable (we focus on the sample of households with less than 80 percent rice calorie share, though the results are robust to other thresholds). We find that the point estimate of the elasticity of meat consumption with respect to the price of rice is negative as predicted, though it is not statistically significant. However, one limitation of this analysis is that in Hunan, only about 45 percent of households reported meat consumption.[27] Therefore, in column 6 we focus on households that consume at least 50g of meat per person in round 1, which is still a very modest amount.[28] Here, the results are more evident; a one percent increase in the price of rice leads to a large (1.13 percent), statistically significant decrease in meat consumption, as predicted by the model.

Thus, again, while our primary goal was to document the existence of Giffen behavior, these two results (the inverted-U shape of the response of rice consumption to a change in price

[27] Though we condition on the staple calorie share in our regressions, the residual is not simply calories from meat.
[28] While it may seem natural to have run all the specifications above stratifying based on meat consumption rather than staple calorie share, the latter is more general and does not rely on our ability to specifically identify meat as the (only) fancy good.

and the decline in meat consumption in response to a change in the price of rice) support the characteristic-preference, subsistence model of consumption with a basic and fancy good outlined above.

IV. D. Gansu

As shown in table 3, wheat-based foods (primarily buns, the simple bread *mo*, and noodles), are the staple good in Gansu. However, not all wheat-based foods are made at home from flour; most notably, noodles are often either consumed at restaurants or road-side food stalls, or purchased from shops as a prepared or packaged food. Since the subsidy we provided applied only to the purchase of wheat flour, for our analysis we use only the consumption of wheat foods typically produced at home from flour.[29] And, as suggested by the calculations in the appendix, because there is some consumption of these other forms of wheat, our threshold staple calorie share for Giffen behavior based on wheat flour alone is closer to .70.[30] Table 7 presents the main results. In contrast to the case of Hunan, the coefficient is negative for the full sample in column 1, and for those below the staple calorie share threshold of 70 percent, the coefficient is positive, but extremely small and not statistically significantly different from zero. In addition, there's no evidence that wheat is even an inferior good in these cases.

Looking across alternative thresholds in columns 4 through 10, we do find that the coefficients increase and ultimately turn positive as the staple calorie share decreases toward 60 percent, consistent with excluding more and more households that are likely to be below the subsistence consumption zone; however, the coefficient then abruptly declines when the share is lowered to 55 percent, and in none of the cases are the coefficients statistically significant.

As the model suggested and the analysis of Hunan revealed, focusing only on those below a certain threshold risks including those who may be too wealthy to be Giffen consumers. While in Hunan we were able to detect Giffen behavior even under the more conservative approach (i.e., without appropriately parsing the data), it may be that we are simply unable to in Gansu. As in Hunan, the coefficients from the weighted regressions depicted in Figure 8 reveal an inverted-U response of wheat consumption to an own-price change over the range of initial

[29] Over 90 percent of the consumption of wheat-based foods in Gansu was reported as 'wheat flour,' with most of the remainder reported as noodles. However, we can't rule out that some noodles were made at home from flour but recorded as noodles, or that some consumers mistakenly reported purchased bread as wheat flour.

staple calorie share, though no coefficient is statistically significantly different from zero at the five percent level over this interval. The range of positive point estimates is both lower and narrower than in Hunan, ranging only from approximately .40 to .60; correspondingly, column 11 of table 7 shows that if we examine households in this range, there is evidence of Giffen behavior, with a large elasticity (1.07), statistically significant at the 10 percent level. While we are of course concerned about the inherent biases in searching over many intervals for a result, both the theory outlined above and the pattern observed in Figure 8 point to the need to examine only those who are poor, while excluding those who are too poor and not poor enough, in testing for Giffen behavior. If not as compelling as the evidence in Hunan, the results are at least strongly suggestive of Giffen behavior in Gansu.

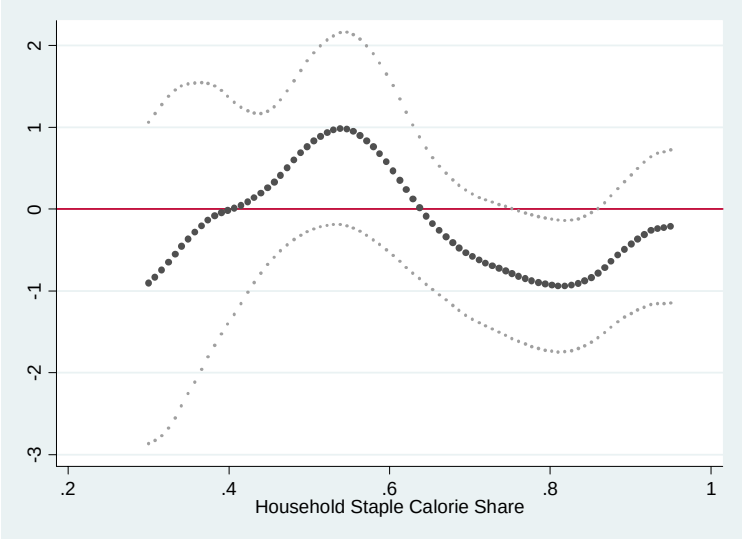

Figure 8: Coefficient Plot for Gansu

Without discounting this last result, we turn now to consider possible explanations for why the evidence of Giffen behavior in Gansu is less immediately evident and precisely estimated than in Hunan. The models above suggest that Giffen behavior is most likely to be found among consumers whose diet consists primarily of a single staple good, with relatively few substitutes, and a fancy good, which is taste-preferred but a more expensive source of nutrition. We consider two potential failures of these conditions in Gansu. First, in our sample

[30] Alternatively, we could use a staple calorie share of .80 based on consumption of all wheat foods, rather than just those produced at home from flour.

there is very little consumption of the fancy good, meat.[31] As shown in table 3, households in Gansu receive on average only 1 percent of their calories from meat, which is even less than the 7 percent observed in Hunan; further, only one quarter of households reported meat consumption in our first period consumption diary. The bulk of non-staple calories come largely from vegetables (especially potatoes, which themselves may potentially be a staple food) and oil, neither of which are likely to be considered a fancy good. With little consumption of the fancy good it is perhaps not surprising that most households do not behave like Giffen consumers in Gansu. There is simply no way for them to finance additional purchases of rice by reducing meat, since they are consuming almost no meat to begin with.[32] This also suggests that the best place to find Giffen behavior is among those consuming a nontrivial amount of meat. Therefore, in column 1 of table 8, we consider only households that consume at least 50 grams of meat per person in the initial period. And, though the sample shrinks considerably because meat consumption is so uncommon, we do find evidence of Giffen behavior among this group, with a 1 percent increase in the price of wheat causing a 1.3 percent increase in wheat consumption.

Gansu also departs from the ideal conditions for Giffen behavior in that wheat as a staple is consumed in a number of other forms that may act as substitutes for each other, many of which are not made directly by consumers at home from wheat flour. Unfortunately, our experimental design failed to account for this additional complexity.[33] In Hunan, the staple good, rice, is consumed typically only in its basic form. By contrast, in Gansu wheat is consumed as *mo* and buns made at home, plus noodles, and other wheat-based, prepared foods like bread, biscuits or deep-fried dough purchased from shops or food stalls. While table 3 showed that average pre-treatment wheat consumption per capita in Gansu was 344g, typically about 34 grams, or 10 percent, of that wheat is from items other than *mo* or buns. If a household consumes their staple food in many forms and the price of one increases, they may not need to engage in Giffen

[31] This result was unanticipated, since the northern provinces in our original paper (Jensen and Miller 2002), and our field test of the survey for the current study, revealed considerably more meat consumption in Gansu.

[32] While there is some consumption of pulses and, to a lesser extent, dairy, these goods are also unlikely to be regarded as fancy goods in the way that meat is, since most households turn to these goods only when they cannot afford meat. Further, there is no way to cut back consumption of these foods while maintaining protein intake; with meat, households can reduce consumption but switch to pulses as a less expensive source of protein.

[33] Though in selecting sample sites, the authors personally only visited two of the counties in Gansu (Anding and Yuzhong); these counties, both with significant Muslim populations who traditionally consume primarily the home made bread *mo*, fit the pattern better, with 88% of all wheat consumption coming from flour, compared to 74% in the other three counties. If we limit our analysis to just these two counties, we find a positive coefficient for all staple calorie share thresholds, though due to the smaller samples, the coefficients are not statistically significant.

behavior because they can reduce consumption of that one and increase consumption of the other, substitutable forms of the staple that did not experience the price increase. While this is unlikely to happen often in reality because the price of all the forms of the staple will be linked to the price of the raw ingredient (here, wheat), the unique structure of our subsidy did just that, subsidizing only the form of the staple prepared at home, and not the close substitutes purchased in stores. This may both explain why we do not find widespread evidence of Giffen behavior in Gansu, and also suggests we might find such behavior if we focus on those households where consumption of these other forms of wheat is small or zero.[34] Column 2 of table 8 provides some suggestive evidence of this possibility, focusing on the condition that the household consumes less than 50g of these alternative forms of wheat. Among this group there is again statistically significant evidence of Giffen behavior, with a very large elasticity.

Overall then, while the results for Gansu do not yield as evident, robust evidence of Giffen behavior as was found for Hunan, we believe this is most likely due to our failure to recognize that for the majority of households in our sample, diets do not conform to two of the basic conditions under which we predict Giffen behavior (consumption of a fancy good, and a staple good for which there are no close substitutes). When we restrict our sample to take these factors into consideration, we do find evidence of Giffen behavior, though the samples are smaller, precisely because most households do not conform to the conditions in Gansu. It is possible that if we sampled a slightly wealthier group of households that consume more of the fancy good, and perhaps altered our experimental design (e.g., to subsidize all wheat foods, not just wheat flour), we might find stronger evidence of Giffen behavior.

IV.E. Addressing Potential Alternative Explanations for the Results

The analysis so far provides robust evidence that price subsidies for rice caused decreases in rice consumption in Hunan, with somewhat weaker evidence for wheat in Gansu. However, there are two alternative explanations for these results beyond Giffen behavior that need to be explored. First, there is the possibility that households viewed the vouchers as a signal about the value of the staple good. For example, consumers might interpret a subsidy as an attempt to encourage people to eat more of the good, perhaps because of its health benefits. Alternatively, there may be a behavioral effect whereby the vouchers enhance the salience of the staple good,

[34] Some of this variation is geographic or based on religion, as noted above.

or where households feel that they should eat more of it in order to take advantage of the subsidy before it runs out. However, in these cases we would expect the vouchers to increase consumption, the opposite of what is observed as Giffen behavior. Alternatively, and perhaps less likely, households may view the vouchers as providing adverse information about the staple good; for example, they may view the attempt to sell more rice as an indication that there is something wrong with the current stock of rice, in which case they might want to consume less of it (though consumers were told the subsidies were being provided by outside researchers rather than the merchants). But since the effects varied by the staple calorie share, to explain our results it would have to be that the vouchers had a salience or signal effect only for some subset of households based on their calorie share (or there was a signal to all households, but only some were in a situation that allowed or required them to respond to it), which seems less likely.

A second concern is the possibility that households cheated,[35] for example by swapping vouchers for cash instead of using them for purchases of the staple good,[36] or reselling rice or wheat purchased with the vouchers at a higher price. In the extreme case where all vouchers are sold for their full face value, the voucher program would have been a pure wealth shock, and consumption of an inferior good like rice or wheat would be expected to decline even though the effective price of these staples had not changed. In less extreme cases, selling only some of the vouchers at less than face value would have exaggerated the wealth effect of the subsidy.[37]

Preventing cashing out of the vouchers was one of our primary concerns in designing the intervention. However, in doing so we also wanted to ensure that the process of redeeming the vouchers would be as much like an ordinary market transaction as possible, and to keep the administrative burden of the intervention manageable. In addition, while we wanted to prevent cashing out of vouchers, we also wanted to allow for the fact that a natural reaction to receiving access to discounted rice or wheat would be for households to build up their stores of these goods, which ostensibly might look very similar to cashing out (i.e., the number of vouchers redeemed is far in excess of the amount of rice or wheat people report consuming).

[35] Cheating where shopkeepers do not provide the full subsidy to consumers (for example, those with poor math skills) effectively lowers the value of the subsidy, so the Giffen behavior we find would likely have been even stronger had such cheating not occurred.
[36] Most shopkeepers sold only grain, so most households could not have exchanged the vouchers for other foods.
[37] Finally, if households bought rice at subsidized prices on behalf of (or as a gift to) their friends or relatives but do not make a profit from doing so, this does not affect the households' wealth and thus does not bias our experiment.

With these concerns in mind, a number of safeguards were built into the experimental design. As mentioned earlier, the consent scripts given to the households in the treatment groups stated that they were explicitly prohibited from selling the vouchers or the rice or wheat bought with the vouchers. Households were also told that there would be periodic monitoring of their compliance, and that any households found to be violating this condition would be dismissed from the program. Our native Chinese implementation team, which is very familiar with the population from which our survey households were drawn, felt that in light of such a rule the intervention households would be very unlikely to cash out the vouchers (although they would be likely to spend vouchers to build up their stores).

One fifth of the total vouchers were distributed to households each month, although all vouchers remained valid until the end of the intervention. Because of this, households engaging in early cashing out would be limited in their extent to do so (since they only had a small part of the vouchers in hand) and would face losing the value of all future vouchers if they were caught. For our purposes, the crucial question is whether there was cashing out before the second round of the survey, since this is the only round for which the subsidy was in effect; cashing out of vouchers after the second survey would not significantly affect our results, since the third round of the survey was not administered until two months after the intervention's end, by which time the households would have presumably exhausted much of the benefit of the subsidy (either in the form of legitimately stored rice or wheat, or in income from cashing out vouchers). At the time of the second-round survey, a significant amount of the benefit of the program still lay in the future, which would therefore have reduce households' incentives to engage in cashing out.

In addition, since households consume so much of the staple, it is unclear they would gain much by trading the vouchers for cash, since they would be unlikely to receive the full cash value of the vouchers, and much of the cash received would eventually be used to purchase more of the staple (for which they would now have to pay a higher price, having sold away their vouchers). Faced with the sanctioned opportunity to purchase the staple at the subsidized prices and store it, or the prohibited opportunity to cash out of the vouchers, it seems that for many households the risks associated with the latter would outweigh the potential gains.[38]

[38] Recall that storage itself is not a particular concern for our experiment, since we use intake data rather than purchase data as our measure of demand. There may be concerns about a behavioral effect whereby having more around encourages you to eat more, such as due to a lack of self-control; however, if this were happening we would expect consumption to increase in response to the subsidy, not decrease.

The participating shopkeepers were also given incentives to prevent cashing out. While they were compensated for the cost of the vouchers, they were also given a lump sum payment at the end of the intervention, and told that they would only receive the lump sum if they were found to have complied with the guidelines for the intervention, which included preventing resale and/or cashing out of vouchers. In order to ensure that only intervention households were allowed to redeem vouchers, redeemers were required to sign the vouchers (which were printed in Beijing in multi-color ink and bore a special stamp, making them difficult to counterfeit in the survey regions) at the time of redemption. These signatures were later audited by our managers to check for authenticity of the vouchers and legitimacy of the household signatures before making reimbursement payments to the shopkeepers.[39]

In addition, the payments were made to shopkeepers in two stages. The first payment was made soon after the second round of the survey (around 3.75 months into the intervention). The second payment, which included both reimbursement for the vouchers used after the second round of the survey and a bonus for compliance, was made after the intervention ended. Thus, over the time period up to and including the second round of the survey, the shopkeepers, knowing that they would lose their final bonus if they were found to cheat, had a strong incentive to prevent cashing out at the time of the second round of the survey. Indeed, if they could be persuaded to participate in such a venture, they would likely only do so if they gained a significant portion of the proceeds, which means that, to the extent that households were able to cash out vouchers, their gains would be reduced, further reducing their incentive to do so.

The safeguards discussed above were accompanied by monitoring and auditing to check for compliance. These audits did not discover any such cheating, and our survey personnel, who visited the households, did not discover evidence of cashing out.

Beyond that, evidence on voucher use also suggests that cashing out could not have been significant or widespread.[40] An ideal measure of whether households had cashed out vouchers would compare, for each household, the total number of vouchers redeemed over the course of the intervention with the total amount of rice consumed by the household and any increase in rice storage. However, this measure is simply not feasible since it would require continuously

[39] Our Chinese management team was the residual claimant on the value of unredeemed vouchers, and so they, themselves, had a strong incentive to enforce the rules of the intervention and prevent cashing out.

[40] Due to administrative difficulties in assigning and recovering individual identifiers from the vouchers, we unfortunately have only data on aggregate voucher usage to work with.

observing both variables for the whole period. Since our consumption data is based on only single day observations on the survey dates, our estimate of total consumption over the subsidy period is imprecise.[41] In addition, while we attempted to collect data on storage, response rates for the storage questions were very low because of respondents' difficulties in interpreting the questions. As a result, while these data can provide broad guidance in understanding the implementation of the intervention, the inherent imprecision associated with these measures is quite high. Nevertheless, for the sake of completeness we present approximate calculations.

Each household was issued vouchers sufficient to purchase 750g of the staple per person per day. This corresponds to vouchers sufficient to purchase (on average) 2106 grams per day of rice for a typical household in Hunan. Overall, only 51% of vouchers that had been distributed as of the second survey had actually been redeemed by that time, meaning that the average household had redeemed the equivalent of 1078 grams per day.[42] Estimated daily rice consumption for subsidized households during the subsidy period was 955 grams, implying a residual difference of 123 grams of rice per household per day, or 10% of the total number of vouchers redeemed before the second round of the intervention. However, as stated, it is likely that households used the subsidy to stock up on rice for later consumption. While our storage data are limited, we find that on average, household rice stores increased from 0.6 *jin* to 14.5 *jin*,[43] which corresponds to redeeming an additional 74g of vouchers per household per day, accounting for much of the discrepancy between rice consumed and vouchers redeemed. And observations by our survey teams corroborate that households were, in fact, increasing storage during this time. Thus, as a rough approximation, only 3%[44] more vouchers were redeemed than

[41] And there is evidence of seasonality in consumption, especially for wheat in Gansu, with the control groups in each county displaying a decline in consumption between rounds 1 and 2. Thus, in estimating the consumption of subsidy households during the subsidy period, we need to take into consideration that the round 2 consumption will be an underestimate of the consumption during a typical day of the subsidy period. To correct for this, we take the change in average consumption between rounds 1 and 2 for the control group in each county, assume a linear trend in consumption, and use this to adjust the round 2 consumption estimates for the treatment group.

[42] Overall, 76% of all vouchers issued were redeemed; as expected, there was a substantial increase in voucher redemption as the subsidy period drew to a close.

[43] Due to low response rates (19% in round 2) we base this calculation only on households that responded to the storage question in both the first and second rounds of the survey.

[44] While estimates at the county level are less precise, the only real outlier, with 217g grams or 10% more vouchers redeemed than can be accounted for by consumption and storage is Pingjiang county. To the extent that we view this as an outlier, the results of table 4 are robust to removing this county.

were consumed or stored,[45] suggesting that if there were any cashing out or re-selling, it was extremely limited.[46]

In Gansu, a typical household received 1996 grams of vouchers per day, and only 46% of vouchers available before the second-round survey were redeemed before that survey. Average household wheat intake in the first two rounds of the survey was 747g, while approximately 942g worth of vouchers per day were redeemed, for a difference of 195g per household per day. There is also evidence of increased storage in Gansu, which accounts for approximately 72g of additional voucher usage per day, leaving approximately 123g (about 1 cup) of voucher redemptions unaccounted for, and a net-of-storage excess voucher redemption rate of 11%.[47]

There are in particular two counties in Gansu that account for much of the discrepancy; Kongdong (35% unaccounted for vouchers) and Anding (22%). We discovered that the high rate of voucher redemptions in Anding was due to the implementation team departing from our protocol and explicitly advising households to purchase as much wheat as possible and store it in order to take advantage of the subsidy program.[48] And the implementation team reports that households were, in fact, purchasing and storing a great deal of extra wheat in Anding (given the imperfections in our storage data, it would not be surprising if we did not measure this increase). We have been unable to uncover the reason for the high voucher redemption rate in Kongdong, although our ground personnel report high storage levels and little evidence of cashing out of vouchers.[49] While we have no direct evidence of cheating in these counties and the high redemption rates were apparently due to increasing wheat storage, as an additional robustness check we estimated regression (1) for Gansu under two scenarios. The first excludes just Kongdong, for which we have no clear reason for the discrepancy. Doing so, the resulting elasticity estimate for the .4 - .6 staple-calorie share group actually increases in both magnitude and statistical significance (1.37 (.67)) relative to the results using all counties (1.06 (.56)).

[45] Further, there may be additional 'leakage' our survey doesn't capture, such as consumption by visitors to the household, or rice lost or wasted during the cooking process, which may further explain the remaining discrepancy.
[46] While it is possible that households cashed out vouchers and then inflated their reported rice consumption to hide what they had done, this type of sophisticated cheating would work against our finding Giffen behavior.
[47] It is likely that in Gansu leakage is somewhat higher than in Hunan since flour is frequently used incidentally in the cooking process (e.g., covering surfaces for kneading bread) in ways that may not appear in the intake data.
[48] To the extent that this advice encourages households to reduce consumption expenditure today in order to purchase and store wheat, this might work against our finding of Giffen behavior since when households spend less on current consumption they tend to consume relatively more wheat.

Excluding both Anding and Kongdong, which reduces the sample size by 42%, results in an elasticity estimate of .79 with a p-value of .27. Thus, while the elasticity estimate remains positive, it is no longer statistically significant.[50]

V. CONCLUSION

We find strong, clear evidence of Giffen behavior among poor households in Hunan, China, and somewhat less robust evidence in Gansu. To the best of our knowledge, this is the first rigorous empirical evidence of Giffen behavior. It is ironic that despite a long search, in sometimes unusual settings, we found examples in the most widely consumed foods for the most populous nation in the history of humanity. However, the examples were found exactly where theory would predict they should occur; impoverished consumers, heavily dependent on a staple good, with limited substitution possibilities.

The results also underscore the vulnerability of extremely poor households to staple food price changes, and provide support for a view of very poor consumers as behaving as if they face a subsistence constraint and making consumption decisions in order to maintain nutritional sufficiency in the face of a changing environment. While consumers prefer to consume foods with non-nutritive attributes if they can afford them, they will trade-off these factors in order to maintain nutrition when the price of the staple food increases. However, while consumers behave in some ways as the subsistence model predicts, there remains important variation in tastes, as between those consuming the rice-based and wheat-based diets in China, that must also be taken into account. A complete understanding of the interaction between nutrition- and taste-based factors in poor consumers' decision-making processes is beyond this scope of this paper but would have important implications for understanding the well-being and nutritional status of the poor, and would also have policy implications regarding food price subsidies or taxation.

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[49] In fact, both counties show large increases in reported wheat purchases between the first and second round of the survey (despite there being a 40% across-the-board decline in wheat consumption and all other counties reporting reduced purchases). Reported purchases match up well with voucher usage in Anding and Kongdong.

[50] Running the main regression in equation (1) with interactions for whether the household was a treated household in Anding or Kongdong, we are unable to reject the null hypothesis that these counties are the same as the other Gansu counties. For this reason, we have not eliminated them from the regressions reported in tables 7 and 8.

REFERENCES

Baruch, Shmuel and Yakar Kannai (2001). "Inferior Goods, Giffen Goods, and Shochu." In G. Debreu, W. Neuefeind and W. Trockel (eds.), *Economics Essays, A Festschrift for Werner Hildenbrand*, Heidelberg, Springer-Verlag, 9-17.

Battalio, Raymond C., John H. Kagel, and Carl A. Kogut (1991). "Experimental Confirmation of the Existence of a Giffen Good," *American Economic Review*, 81(4) p. 961-70.

Boland, Lawrence A. (1977). "Giffen Goods, Market Prices and Testability," *Australian Economic Papers,* 16 (28). p 72-85.

Bopp, Anthony (1983). "The Demand for Kerosene: A Modern Giffen Good," *Applied Economics*, 15(4). p 459-468.

Dorfman, Robert, Paul A. Samuelson, and Robert M. Solow (1958). *Linear Programming and Economic Analysis*. McGraw Hill: New York.

Dougan, William R. (2002). "Giffen Goods and the Law of Demand," *Journal of Political Economy*, 90(4), p. 809-15.

Dwyer, Gerald P. and Cotton M. Lindsay (1984). "Robert Giffen and the Irish Potato," *American Economic Review*, 74(1), p. 188-192.

Gilley, Otis and Gordon V. Karels (1991). "In Search of Giffen Behavior," *Economic Inquiry*, 29(1), p. 182-9.

Halbrendt, Catherine, Francis Tuan, Conrado Gempesaw and Dimphna Dolk-Etz (1994). "Rural Chinese Food Consumption: The Case of Guandong," *American Journal of Agricultural Economics*, 76, p. 794-99.

Jensen, Robert T. and Nolan Miller (2002). "Giffen Behavior in China: Evidence from the China Health and Nutrition Survey," Faculty Research Working Paper RWP02-014, John F. Kennedy School of Government, Harvard University.

- - and - -(2007). "Gender and the Demand for Nutrition: Evidence from an Experimental Intervention," mimeo, John F. Kennedy School of Government, Harvard University.

Koenker, Roger (1977). "Was Bread Giffen? The Demand for Food in England Circa 1790," *The Review of Economics and Statistics*, 59(2), p. 225-229.

Lancaster, Kelvin J (1966). "A New Approach to Consumer Theory," *Journal of Political Economy*, 74(2), p. 132-157.

Lipsey, Richard G. and Gideon Rosenbluth (1971). "A Contribution to the New Theory of Demand: A Rehabilitation of the Giffen Good," *Canadian Journal of Economics*, 4(2), p. 131-163.

Marshall, Alfred (1895). *Principles of Economics*. Macmillan: London.

McDonough, Terrence and Joseph Eisenhauer (1995). "Sir Robert Giffen and the Great Potato Famine: A Discussion of the Role of a Legend in Neoclassical Economics," *Journal of Economic Issues*, 29(3), p. 747-759.

Rosen, Sherwin (1999). "Potato Paradoxes," *Journal of Political Economy*, 107 (6), Part 2, p. S294-313.

Spiegel, Uriel (1994) "The Case of a 'Giffen Good'," *Journal of Economic Education*, c, p. 137–47.

Stigler, George (1947). "Notes on the History of the Giffen Paradox," *Journal of Political Economy*, 55(2), p. 152-156.

- - (1987). *The Theory of Price, Fourth Edition*. The Macmillan Company: New York.

Thomas, Duncan and John Strauss (1997). "Health and Wages: Evidence on Men and Women in Urban Brazil," *Journal of Econometrics*, 77(1), p. 159-85.

van Marrewijk, Charles and Peter A.G. van Bergeijk (1990). "Giffen Goods and the Subsistence Level," *History of Political Economy*, 22(1), p. 145-8.

Wichers, Robert (1994) "In Search of Giffen Behavior: Comment," *Economic Inquiry*, 32, p. 166-167.

APPENDIX: THE MINIMUM COST DIET AND THE STAPLE CALORIE SHARE

Individual requirements for calories and essential amino acids vary a great deal and depend on a range of characteristics. To investigate the extent to which it might be possible to judge whether a particular person was meeting their essential nutritional needs, we solved a simplified version of the "diet problem," i.e., minimizing the cost of achieving certain nutritional requirements. To capture the importance of complete protein sources, using information from the National Research Council we imposed intake requirements for calories and 11 amino acids.[A1] We considered diets consisting of rice and bean curd in Hunan, and wheat flour and bean curd in Gansu. In both provinces, the staple is the cheapest source of calories, but it is relatively deficient in the essential amino acid lysine. Complementing cereal grains with legumes such as in bean curd is typically the cheapest way to ensure that a person receives all essential amino acids. Typically, only small amounts of bean curd are needed to complete the protein.

Nutritional content information was taken from the USDA National Nutrient Database for Standard Reference (the Chinese food tables used in the paper do not contain information on amino acid content of foods).[A2] Calorie requirements are computed using the Estimated Energy Requirement equations from the Institute of Medicine.[A3] In order to capture the realities of cooking technology, we assume that households receive 13% of their calories from fats, in this case in the form of cooking oil. In most cases this implies consumption of less than one tablespoon of oil per day.

We considered a number of different representative "people" of both sexes with a range of different height, weight, and activity level specifications ("V" denotes very active, "A" denotes active, "L" denotes less active, and "S" denotes sedentary). Scenarios G – J are chosen with typical heights for Chinese men and women who are slightly underweight or normal weight (by body mass index). For each person, we solved for the minimum-cost diet that satisfies the nutritional requirements for calories and each of the essential amino acids. In all cases, the calorie and lysine constraints bind and determine the solution. Hence to conserve space we do not report the other amino acid requirements.

The results of this exercise show wide variability in both caloric requirements and the cost of the least-cost diet (see table below). Daily calories required and the least-cost diet range from 1351 calories and 1.15 yuan/day in Gansu (1.21 in Hunan) for a sedentary elderly woman (scenario E) to 4264 calories and 2.69 yuan/day in Gansu (2.91 in Hunan) for an active young man (scenario A). Thus the calorie

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[A1] National Research Council, *Dietary Reference Intakes for Energy, Carbohydrates, Fiber, Fat, Fatty Acids, Cholesterol, Protein, And Amino Acids (Dietary Reference Intakes),* National Academies Press, Washington DC, 2005.

[A2] USDA National Nutrient Database for Standard Reference, http://www.nal.usda.gov/fnic/foodcomp/search/.

[A3] Gerrior, S. et al., "An Easy Approach to Calculating Estimated Energy Requirements," *Preventing Chronic Diesase,* 2006, October; *3(4)*: A129.

requirements and income requirements necessary to be in good nutrition are both highly variable and highly sensitive to the underlying characteristics of the person under discussion.

We also report the proportion of calories from the staple for each scenario. The staple calorie share in the least-cost diet, while variable, is significantly less variable than either total calories or cost, ranging from 0.79 to 0.86 in Hunan and 0.78 to 0.85 in Gansu. While this is the staple calorie share associated with the least-cost diet, we are interested in those who have more than enough money, and thus will not purchase the least-cost diet. Since wealthier people will tend to get a greater proportion of their calories from non-staple sources, this suggests a reasonable cut-off of somewhere around 0.8. We expect that people who get less than 80 percent of their calories from the staple will have some slack in their food budget, and thus it will be theoretically possible for them to exhibit Giffen behavior, while those with staple calorie share chronically greater than 0.9 will likely be deprived of essential nutrients.[A4]

Finally, we must keep in mind that households in Gansu get part of their staple calories from noodles and other forms of wheat (approx. 7% percent), which we do not count as part of "staple calories." Thus, an appropriate cut-off for Gansu may be more in the range of 0.7 than 0.8.

Appendix Table. Staple Calorie Share of Minimum Cost Diet

Scenario	A	B	C	D	E	F	G	H	I	J
Sex	M	M	M	F	F	F	M	F	M	F
Age	25	35	75	35	85	22	40	40	40	40
Height (feet)	6'2"	5'9"	5'4"	5'8"	5'2"	5'4	5'7"	5'2"	5'7"	5'2"
Height (m)	1.88	1.75	1.63	1.73	1.57	1.63	1.70	1.57	1.70	1.57
Activity	V	L	S	L	S	V	A	A	A	A
Weight (lbs.)	220	180	120	140	110	130	121	104	141	121
Weight (kg)	100	82	55	64	50	59	55	47	64	55
Nutrient Requirements										
Calories	4264	2812	1727	2223	1351	2717	2554	2070	2718	2174
Lysine (mg)	3100	2536	1691	1973	1550	1832	1705	1465	1987	1698
Least-Cost Diet (Hunan)										
Rice (g)	996	636	385	504	291	641	603	485	634	503
Bean Curd (g)	123	208	162	156	185	41	35	50	81	93
Cooking Oil (g)	19.1	12.6	7.7	10	6.1	12.2	11.4	9.3	12.2	9.7
Cost (yuan)	2.91	2.17	1.40	1.70	1.21	1.78	1.67	1.39	1.86	1.54
Staple Calorie Share	0.85	0.82	0.81	0.83	0.79	0.86	0.86	0.86	0.85	0.84
Least-Cost Diet (Gansu)										
Wheat (g)	986	629	381	499	288	635	597	480	628	498
Bean Curd (g)	198	256	191	194	207	89	80	86	129	131
Cooking Oil (g)	19.1	12.6	7.7	10	6.1	12.2	11.4	9.3	12.2	9.7
Cost (yuan)	2.69	2.03	1.31	1.59	1.15	1.64	1.53	1.29	1.72	1.43
Staple Calorie Share	0.84	0.81	0.80	0.82	0.78	0.85	0.85	0.84	0.84	0.83

1 cup uncooked rice = 185 grams. 1 cup uncooked flour = 125 grams. 1 tablespoon cooking oil = 13.6 grams.

[A4] Nutritional sufficiency does not require consuming all essential amino acids at every meal. Thus even a consumer with a very high staple calorie share on the day of our survey may be nutritionally stable provided that they consumed more non-staples on other days.

Table 1. Means and Standard Deviations of Key Variables

HUNAN

	Control	.1 yuan/*jin* subsidy	.2 yuan/*jin* subsidy	.3 yuan/*jin* subsidy
Family size	2.8	2.9	3.0	2.7
	[1.3]	[1.3]	[1.4]	[1.1]
# of kids (≤16)	0.5	0.5	0.4	0.4
	[.68]	[.6883]	[.6687]	[.61]
Female head	0.34	0.37	0.37	0.40
	[.47]	[.4844]	[.4844]	[.49]
Income per capita	604	557	703	751
	[1227]	[797]	[959]	[2451]
Expenditure per capita	316	330	299	361
	[252]	[316]	[290]	[483]
Calories per capita	1767	1783	1817	1851
	[628]	[588]	[549]	[601]
Rice per capita (g)	317	325	340	338
	[122]	[129]	[128]	[120]
Meat per capita (g)	50.4	42.4	40.7	52.8
	[81.6]	[61.0]	[59.2]	[70.3]
Rice calorie share	0.639	0.636	0.645	0.642
	[.188]	[.186]	[.158]	[.152]
Observations	161	162	162	159

GANSU

	Control	.1 yuan/*jin* subsidy	.2 yuan/*jin* subsidy	.3 yuan/*jin* subsidy
Family size	2.9	2.7	2.7	2.7
	[1.1]	[1.1]	[.95]	[1.1]
# of kids (≤16)	0.56	0.55	0.54	0.54
	[.64]	[.69]	[.66]	[.60]
Female head	0.44	0.40	0.44	0.44
	[.50]	[.49]	[.50]	[.50]
Income per capita	694	694	724	726
	[663]	[652]	[800]	[697]
Expenditure per capita	202	228	198	216
	[247]	[214]	[231]	[201]
Calories per capita	1737	1732	1716	1655
	[496]	[553]	[500]	[520]
Wheat per capita (g)	352.6	353.4	340.7	328.7
	[132]	[147]	[136]	[120]
Meat per capita (g)	13.9	9.7	13.5	13.6
	[30.9]	[23.8]	[33.7]	[31.1]
Rice calorie share	0.691	0.691	0.678	0.680
	[.176]	[.172]	[.181]	[.165]
Observations	163	162	162	162

Notes: Standard deviations in brackets. All consumption figures are in grams per capita. Calorie share is the percent of total calories attributable to the particular food category. Income and expenditure per capita are in 2006 yuan (Rmb). 1 *jin* = 500g.

Table 2. Food Characteristics per Yuan

HUNAN

	Price (Yuan/kg)	Grams per Yuan	Calories Per Gram	Calories Per Yuan	Protein (g) Per Gram	Protein (g) Per Yuan	Fat (g) per Gram	Fat (g) per Yuan
Rice	2.48	403	3.47	***1399***	0.08	32	0.01	2
Wheat	2.82	355	3.44	1221	0.11	40	0.02	5
Pork	12.60	79	3.95	313	0.13	10	0.37	***29***
Eggs	9.32	107	1.37	147	0.13	14	0.09	10
Millet	6.66	150	3.58	537	0.09	14	0.03	5
Cabbage	1.60	***625***	0.23	141	0.02	11	0.01	3
Bean Curd	2.38	420	0.57	239	0.07	***29***	0.03	11
		BULK		ENERGY		PROTEIN		TASTE

GANSU

	Price (Yuan/kg)	Grams per Yuan	Calories Per Gram	Calories Per Yuan	Protein (g) Per Gram	Protein (g) Per Yuan	Fat (g) per Gram	Fat (g) per Yuan
Rice	3.54	282	3.47	980	0.08	22	0.01	2
Wheat	2.08	480	3.44	***1655***	0.11	54	0.02	7
Pork	11.62	86	3.95	340	0.13	11	0.37	***32***
Eggs	6.22	161	1.37	220	0.13	20	0.09	14
Millet	3.24	308	3.58	1105	0.09	28	0.03	10
Cabbage	1.3	***769***	0.23	173	0.02	14	0.01	4
Bean Curd	2.54	394	0.57	224	0.07	***27***	0.03	10
		BULK		ENERGY		PROTEIN		TASTE

Notes: Rice: late, long-grain (*wanxian*); wheat: standard (*Biaozhunfen*); bean curd (*nandoufu*); cabbage (*Dabaicai (xiaobaikou)*); pork: lean and fatty (*Zhurou (feishou)*); Millet: foxtail (*xioami*); eggs: hen eggs (*jidan*). All quantities are in grams, all prices are in 2006 yuan (Rmb) per kilogram.

Table 3. Daily Consumption Per Capita and Calorie Shares for Food Categories

	HUNAN		GANSU	
	Consumption (g)	Calorie Share	Consumption (g)	Calorie Share
Rice	330	0.64	35	0.07
	[125.4]	[.17]	[69.5]	[.13]
Wheat	42	0.08	344	0.69
	[60.2]	[.12]	[134.3]	[.17]
Other Cereals	1.5	0.00	4.2	0.01
	[21.3]	[.022]	[24.2]	[.050]
Vegetables and fruit	341	0.05	232	0.07
	[194.6]	[.044]	[141.6]	[.045]
Meat (incl. eggs)	47	0.07	13	0.01
	[68.6]	[.11]	[30.1]	[.037]
Pulses	62	0.02	36	0.02
	[102.3]	[.043]	[68.1]	[.056]
Dairy	1	0.00	19	0.01
	[7.4]	[.0031]	[56.6]	[.039]
Fats	26	0.13	23	0.13
	[20.4]	[.095]	[16.3]	[.090]
Calories	1805	--	1710	--
	[591.7]		[517.4]	
Observations	644	644	649	649

Notes: Standard deviations in brackets. All consumption figures are in grams per capita. Calorie share is the percent of total calories attributable to the particular food category.

Table 4. Consumption Response to the Price Subsidy: Hunan

	(1)	(2)	(3)	(4)	(5)	(6)
		INITIAL STAPLE CALORIE SHARE			INITIAL MEAT CONSUMPTION	
	Full Sample	≤.80	>.80	.60 − .80	All (≥0)	>50g
%ΔPrice(rice)	0.235*	0.466***	-0.585**	0.640***	-0.325	-1.125*
	(0.140)	(0.159)	(0.262)	(0.192)	(0.472)	(0.625)
%Δ Earned	0.043***	0.047***	0.024	0.030	0.028	0.105
	(0.014)	(0.016)	(0.023)	(0.019)	(0.050)	(0.069)
%ΔUnearned	-0.044*	-0.038	-0.058	-0.053*	0.061	0.084
	(0.025)	(0.030)	(0.049)	(0.030)	(0.079)	(0.104)
%ΔPeople	0.89***	0.83***	1.16***	0.79***	-0.08	0.03
	(0.08)	(0.09)	(0.15)	(0.14)	(0.27)	(0.36)
Constant	4.1***	5.7***	-1.8	0.8	-12.3***	-49.0***
	(1.0)	(1.1)	(1.7)	(1.3)	(3.1)	(3.7)
Observations	1258	997	261	513	997	452
R^2	0.19	0.20	0.33	0.24	0.09	0.28

Notes: Regressions are county*time fixed-effect regressions where the dependent variable is the arc percent change in household rice consumption. Standard errors clustered at the household level. %ΔPrice(rice) is the change in the subsidy, measured as a percentage of the average price of rice. %ΔEarned is the arc percent change in the household earnings from work; %ΔHH Unearned is the arc percent change in the household income from unearned sources (government payments, pensions, remittances, rent and interest from assets); %ΔPeople is the arc percent change in the number of people living in the household. Initial Staple Calorie Share refers to the share of calories consumed as rice in the pre-intervention period. *Significant at 10 percent level. **Significant at 5 percent level. ***Significant at 1 percent level.

Table 5. Robustness of Results to Alternative Specifications: Hunan

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
		log-log Specification			Consumption Per Capita			Individual Level Data			Expenditure Per Capita Thresholds		
	Full	≤.80	>.80	Full	≤.80	>.80	Full	≤.80	>.80	≥25th	<25th	≥15th	<15th
%ΔPrice(rice)	0.399	0.694**	-0.718**	0.762*	1.348***	-1.348	0.233	0.384**	-0.223	0.286*	0.139	0.301**	-0.132
	(0.254)	(0.304)	(0.294)	(0.423)	(0.476)	(0.842)	(0.144)	(0.169)	(0.225)	(0.167)	(0.238)	(0.153)	(0.288)
%ΔEarned	0.010**	0.012	0.003	0.091**	0.103**	0.041	0.041***	0.046***	0.022	0.039**	0.050**	0.041***	0.054**
	(0.006)	(0.007)	(0.007)	(0.043)	(0.048)	(0.083)	(0.014)	(0.016)	(0.024)	(0.017)	(0.023)	(0.015)	(0.026)
%ΔUnearned	-0.031**	-0.030	-0.038	-0.107	-0.066	-0.225	-0.061**	-0.051	-0.082**	-0.037	-0.068*	-0.033	-0.104**
	(0.018)	(0.020)	(0.025)	(0.072)	(0.080)	(0.174)	(0.027)	(0.033)	(0.041)	(0.030)	(0.040)	(0.028)	(0.046)
%ΔPeople	0.93***	0.85***	1.27***	-0.28	-0.55	0.89	0.01	-0.08	0.27	0.89***	0.86***	0.87***	1.15***
	(0.10)	(0.10)	(0.19)	(0.32)	(0.35)	(0.57)	(0.09)	(0.10)	(0.17)	(0.10)	(0.15)	(0.09)	(0.18)
Constant	0.04**	0.05**	-0.003	11.9***	16.7***	-5.3	5.3***	6.5***	0.8	4.3***	3.4*	3.9***	5.4***
	(0.02)	(0.02)	(0.18)	(3.0)	(3.2)	(6.0)	(1.0)	(1.2)	(1.7)	(1.1)	(1.7)	(1.1)	(2.0)
Observations	1256	997	259	1258	997	261	2755	2191	564	971	287	1083	175
R^2	0.11	0.11	0.31	0.09	0.11	0.18	0.05	0.06	0.10	0.18	0.31	0.19	0.35

Notes: Regressions are county*time fixed-effect regressions where the dependent variable is the arc percent change in household rice consumption. Standard errors clustered at the household level. For columns 4 – 13: %ΔPrice(rice) is the change in the subsidy, measured as a percentage of the average price of rice; %ΔEarned is the arc percent change in the household earnings from work; %ΔHH Unearned is the arc percent change in the household income from unearned sources (government payments, pensions, remittances, rent and interest from assets); and %ΔPeople is the arc percent change in the number of people living in the household. For columns 1 – 3, these percent changes result from using the log of the relevant variables. Initial Staple Calorie Share refers to the share of calories consumed as rice in the pre-intervention period. Initial Expenditure Per Capita refers to a household's percentile in the distribution of expenditure per capita in the pre-intervention period. *Significant at 10 percent level. **Significant at 5 percent level. ***Significant at 1 percent level.

Table 6. Robustness to Alternative Staple Calorie Share Thresholds: Hunan

	(1) ≤.70	(2) ≤.75	(3) ≤.80	(4) ≤.85	(5) ≤.90	(6) >.70	(7) >.75	(8) >.80	(9) >.85	(10) >.90
%ΔPrice(rice)	0.362**	0.461***	0.466***	0.382***	0.270*	0.004	-0.331	-0.585**	-0.934*	-0.617
	(0.184)	(0.174)	(0.159)	(0.145)	(0.143)	(0.203)	(0.207)	(0.262)	(0.471)	(0.681)
%Δ Earned	0.052***	0.049***	0.047***	0.044***	0.043***	0.028	0.028*	0.024	0.027	0.094
	(0.019)	(0.018)	(0.016)	(0.015)	(0.014)	(0.018)	(0.017)	(0.023)	(0.035)	(0.072)
%ΔUnearned	-0.007	-0.027	-0.038	-0.041	-0.044*	-0.093**	-0.076*	-0.058	0.001	-0.036
	(0.034)	(0.031)	(0.030)	(0.027)	(0.026)	(0.037)	(0.044)	(0.049)	(0.085)	(0.154)
%ΔPeople	0.77***	0.79***	0.83***	0.87***	0.87***	1.13***	1.17***	1.16***	1.03***	1.35***
	(0.11)	(0.10)	(0.09)	(0.09)	(0.09)	(0.10)	(0.12)	(0.15)	(0.26)	(0.22)
Constant	7.4***	6.1***	5.7***	4.8***	4.3***	-0.9	-0.3	-1.8	-1.3	2.8
	(1.3)	(1.2)	(1.1)	(1.1)	(1.0)	(1.3)	(1.4)	(1.7)	(2.3)	(4.0)
Observations	777	883	997	1116	1196	481	375	261	142	62
R^2	0.20	0.19	0.20	0.20	0.19	0.30	0.34	0.33	0.31	0.49

Notes: Regressions are county*time fixed-effect regressions where the dependent variable is the arc percent change in household rice consumption. Standard errors clustered at the household level. %ΔPrice(rice) is the change in the subsidy, measured as a percentage of the average price of rice. %ΔEarned is the arc percent change in the household earnings from work; %ΔHH Unearned is the arc percent change in the household income from unearned sources (government payments, pensions, remittances, rent and interest from assets); %ΔPeople is the arc percent change in the number of people living in the household. Initial Staple Calorie Share refers to the share of calories consumed as rice in the pre-intervention period. *Significant at 10 percent level. **Significant at 5 percent level. ***Significant at 1 percent level.

Table 7. Consumption Response to the Subsidy: Gansu

	(1) Full Sample	(2) ≤.70	(3) >.70	(4) ≤.55	(5) ≤.60	(6) ≤.65	(7) ≤.75	(8) ≤.80	(9) ≤.85	(10) ≤.90	(11) .40 − .60
%ΔPrice(wheat)	-0.353	0.024	-0.825**	-0.245	0.309	0.128	0.009	-0.280	-0.321	-0.356	1.065*
	(0.258)	(0.366)	(0.357)	(0.453)	(0.452)	(0.414)	(0.326)	(0.302)	(0.283)	(0.268)	(0.557)
%Δ Earned	0.079**	0.098*	0.041	-0.048	0.023	0.064	0.124***	0.107**	0.100**	0.103***	0.063
	(0.036)	(0.052)	(0.049)	(0.065)	(0.062)	(0.057)	(0.045)	(0.042)	(0.040)	(0.038)	(0.074)
%ΔUnearned	-0.017	-0.048	0.035	0.023	0.045	-0.007	0.005	0.063	0.034	0.009	0.189
	(0.092)	(0.129)	(0.127)	(0.189)	(0.173)	(0.141)	(0.112)	(0.105)	(0.102)	(0.093)	(0.181)
%ΔPeople	0.58***	0.34	0.80***	0.18	0.25	0.24	0.40	0.42*	0.42*	0.53**	0.11
	(0.22)	(0.30)	(0.25)	(0.41)	(0.34)	(0.32)	(0.27)	(0.25)	(0.23)	(0.22)	(0.32)
Constant	-26.1***	-20.8***	-32.8***	-18.7***	-19.5***	-20.3***	-22.9***	-23.3***	-25.8***	-25.7***	-31.6***
	(2.3)	(3.3)	(2.9)	(4.5)	(4.1)	(3.7)	(3.0)	(2.7)	(2.6)	(2.4)	(4.4)
Observations	1269	687	582	406	478	563	843	995	1107	1199	266
R^2	0.08	0.11	0.09	0.17	0.14	0.12	0.09	0.10	0.08	0.08	0.24

Notes: Regressions are county*time fixed-effect regressions where the dependent variable is the arc percent change in household rice consumption. Standard errors clustered at the household level. %ΔPrice(wheat) is the change in the subsidy, measured as a percentage of the average price of wheat. %ΔEarned is the arc percent change in the household earnings from work; %ΔHH Unearned is the arc percent change in the household income from unearned sources (government payments, pensions, remittances, rent and interest from assets); %ΔPeople is the arc percent change in the number of people living in the household. Initial Staple Calorie Share refers to the share of calories consumed as wheat (excluding purchased wheat foods such as noodles or bread) in the pre-intervention period. *Significant at 10 percent level. **Significant at 5 percent level. ***Significant at 1 percent level.

Table 8. Refinements of Consumption Response: Gansu

	(1)	(2)
	Consume >50g meat	Consume <50g Substitute Wheat
%ΔPrice(wheat)	1.327*	1.106*
	(0.701)	(0.566)
%Δ Earned	0.139*	0.156*
	(0.076)	(0.080)
%ΔUnearned	0.059	-0.056
	(0.147)	(0.172)
%ΔPeople	1.70***	0.45
	(0.23)	(0.29)
Constant	0.82	-26.8***
	(5.1)	(5.5)
Observations	107	247
R^2	0.33	0.22

Notes: Regressions are county*time fixed-effect regressions where the dependent variable is the arc percent change in household consumption of wheat. Standard errors clustered at the household level. %ΔPrice(wheat) %ΔPrice(wheat) is the change in the subsidy, measured as a percentage of the average price of wheat. %ΔEarned is the arc percent change in the household earnings from work; %ΔHH Unearned is the arc percent change in the household income from unearned sources (government payments, pensions, remittances, rent and interest from assets); %ΔPeople is the arc percent change in the number of people living in the household. Substitute Wheat refers to consumption of wheat-based foods such as noodles or bread that are purchased in a prepared form, rather than made at home from wheat flour. *Significant at 10 percent level. **Significant at 5 percent level. ***Significant at 1 percent level.