Land Distribution and Welfare in Rural China

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Abstract

Determinants of nutritional status are studied using rural household data from two Chinese provinces. We show that access to land can have value for nutritional status both as a means of generating income but also as a source of cheaper calories relative to the market. These results are consistent with an incomplete market hypothesis and suggest that land redistribution can have a larger impact on nutrition than the redistribution of output from that land. The results point to universal and egalitarian access to land as being central in explaining China's current and historical success in constraining calorific undernutrition.

1 Introduction

Hunger and malnutrition are persistent features of many less developed countries. Public policy research has therefore rightly focused on the causes of undernutrition and the pathways through which policy can affect nutritional outcomes. In this paper we are interested in using household expenditure survey data to try and understand the factors which affect the determination of nutritional status in rural China.[1]

As regards its nutritional record, China represents something of a paradox: low levels of undernutrition have been achieved at low levels of income (see Dreze and

[1] Nutritional status is proxied by per capita calorie availability data which can be calculated from consumption information in household data.

Sen, 1989, 1995; World Bank, 1992, 1997).[2] Comparing India and China in 1990 when GNP per capita was similar reveals that nutritional welfare in China is significantly higher than in India irrespective of the measure chosen (see Table 1).[3] Many of China's nutritional achievements preceded the post-reform high growth era which points to other mechanisms besides income growth as being important in explaining China's nutrition achievements (Piazza, 1986). Explaining this paradox is what provided the original motivation for the paper.

Though widespread provision of basic social services in the countryside could help to explain high health and education indicators it does not suffice to explain the overall paucity of undernutrition. In addition, early analysis of the household data on which this paper is based revealed that borrowing was limited and financial transfers both to and between households were negligible.[4] This raised the question of how were poor village communities able to avoid the undernutrition traps which characterise these entities in the majority of low income countries. Given that aggregate resources are low, the relative lack of undernutrition suggested that Chinese villages were successful at meeting distributional objectives. In this respect, two features set China apart from other low income countries. First, a virtual lack of landlessness and second, highly egalitarian distributions of land.

Given this background, the objectives of the paper are twofold. First, we wish to examine how universal and egalitarian access to land emerges within Chinese villages. This analysis serves as a vehicle for understanding the institutional basis of China's welfare achievements relative to other low income countries. Second, we want to isolate and examine the pathways through which access to land influences calorie availability. This analysis constitutes the core of the paper and provides insights into why universal and egalitarian access to land may have a central bearing on nutritional attainment in rural settings characterised by low incomes and imperfect food markets.

The paper is organized as follows. Section 2 examines the data. Section 3 provides econometric background on how land is allocated by nonmarket village level institutions. Section 4 first examines the theory of how access to land may affect nutritional status in complete and incomplete market settings. We then test the predictions of the theory in household data to gain insights into the mechanisms through which access to land may be influencing nutritional welfare. Section 5 offers concluding comments and traces out broader implications for policy.

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[2] Many of China's nutritional achievements preceded the post-reform high growth era which points to other mechanisms besides income growth as being important in explaining China's nutrition achievements (Piazza, 1986).

[3] China also dominated *all* low income countries in terms of calorie per capita figures despite the fact it is close to the midpoint of these countries in terms of GNP per capita (see World Bank,1993).

[4] If anything resources were flowing in the opposite direction through the operation of quota systems and the upward sharing of taxes (Sah and Stiglitz, 1992).

2 Data

The data used in this paper are drawn from two provincial sub-samples of the Rural Household Sample Survey conducted by the State Statistical Bureau (SSB) of the People's Republic of China.[5,6] Given scarcity of household data on rural China during the transition period they are of considerable interest.[7] The data request to the SSB was designed to allow us to contrast a rich, coastal province where markets have developed rapidly (Jiangsu) with a poor, inland province where market development is restricted and dependence on agriculture is still pronounced (Sichuan) (see Table 2).[8]

As is evident from Table 2, sampling is multistage in design. One third of the counties in a province are sampled, ten villages are drawn from each county and ten households from each village. Statistical inference needs to take this into account and all regressions are reported with Huber standard errors which have been corrected for the effects of clustering (see Deaton, 1997).

A fairly unique feature of the data set are that there are separate, highly detailed series on both income and consumption which are collected throughout the course of the entire year. This feature combined with the fact that daily data entry in household log books is closely monitored by a resident village enumerator and subjected to a rigorous system of cross-checks by SSB officials at different levels is also likely to add to the robustness of the results (see Burgess and Wang, 1995).[9]

[5]The data sets were obtained as part of a joint research programme between the SSB and LSE financed by the Ford Foundation. We are grateful to the Ford Foundation and the SSB for their assistance in providing the data. For a full description of the data sets the reader is referred to Burgess and Wang (1995).

[6]The analysis is predominately cross-sectional and focussed on 1990. The reason for this is practical. Though we have data for 1988-90, detailed information on individuals within households, which is essential, for the study of land allocation or for modelling calorie demand, is only available for 1990.

[7]In 1993, when this data first materialised at the LSE, it represented the only large household data set available outside of China.

[8]If we rank the rural sectors of Chinese provinces according to per capita expenditure (PCE), Jiangsu is located near the top of the distribution whilst Sichuan is located in the lower half of the distribution. At all stages of the analysis we ran regressions where data had been pooled from both provinces and in all cases F tests reject pooling of the data. This both justifies presenting separate results but also suggests that there are significant differences between the two provinces in terms of their underlying economic structures.

[9]Two major corrections to the original consumption data are worth mentioning here. (i) State instead of market prices had been used to value non-marketed home production of grain. Given that rural residents did not have access to grain at subsidised state prices this important element of consumption has to be revalued using the free market price of grain in that locality. (ii) To remove some of the noise in consumption expenditure which is our preferred welfare measure, durable consumption is imputed as 6% of value of the durable stock based on plausible ranges of interest and depreciation rates for a given year. Similar corrections have not been made for housing as there is no significant housing market in rural China to serve as a basis for valuation (see also Chen and Ravallion, 1995).

Information on food consumption consists of consumption both from own production and from purchases. Given that the bulk of households are net sellers home production has been imputed using market selling prices though robustness of results to using alternative imputation procedures have been checked. The survey distinguishes between seventeen different kinds of food, including three categories of cereal, and fourteen non-cereal foods. Information on cereal consumption is obtained from a schedule in the survey on household grain balances. This schedule records additions to and withdrawals from the household stock of grain.[10] Grain in this context refers to quantities in an unhusked as opposed to directly edible form and proper account must be taken of this difference in the conversion to calories. Non-cereal items are obtained from the schedule on food consumption which records quantities of directly edible food consumed. The calorie figures were obtained from the food quantities using food composition tables for China translated into English by Ershow and Wong-Chen (1990).

Land in the SSB survey is divided between cultivable land and hilly field. Cultivable land typically refers to irrigated, agricultural land located in relatively flat areas where grains and other key crops are produced. Hilly field refers to rainfed, marginal land located on the slopes of hills and used for pasture, forestry or marginal non-grain crop production (e.g. fruit trees).[11] Given the large quality differentials between the two types of land and because we are mainly interested in looking at the allocation of land for crop production we have chosen to focus in our regressions only on cultivable land.[12]

3 Institutional Setting

The main form of redistribution in rural China is *via* land. Borrowing is limited and financial transfers both to households by the government and between households are negligible (Burgess 1998a). Universal and egalitarian access to land is what sets China apart from other developing countries. We therefore begin our analysis by examining the manner in which cultivable land is distributed in rural China.

[10] Historically, grain balance was the primary measure of living standards in rural China but it is rapidly being replaced by monetary measures of welfare (e.g. per capita expenditure) as the rural economy becomes increasingly market oriented.

[11] Hilly land is of negligible importance in Jiangsu which is a relatively flat province where it constitutes 2% of total land. In Sichuan which has extensive hilly and mountainous regions hilly field constitutes 25% of total land but this land contributes very little to aggregate *crop* production.

[12] We have run *all* regressions in the paper which include land using total land and this does not change any of the main results. The main effect of introducing hilly field is to reduce the precision of the coefficient estimates, in particular in the case of Sichuan.

3.1 Historical Background

Egalitarian land distribution has its origins in the land reforms of the 1950s. Land scarcity was considered to be the predominant cause of undernutrition and poverty in the pre-communist period and constituted a major focus of class struggle (see Moise, 1983; Piazza, 1986). Radical land reforms, focussed on the confiscation (by force) of land from rich landlords, were enacted from 1947 to 1953 as the Chinese Communist Party took control of the country. These reforms resulted in substantial equalisation of landholding. Collectivisation which took place after 1954 when private ownership and trade of land was banned led to a highly egalitarian distribution of rights to land among households within the same geographical area. Though successful from a distributional perspective, collectivisation was associated with a number of incentive failures which led to its abandonment after 1978 (see Lin, 1992)

The household responsibility system (HRS) which gradually replaced collectivisation strengthened incentives for production by making households residual claimants to the value-added created on their farms subject to meeting various contractual obligations to the village collective and state. By strengthening individual incentives this institutional change resulted in a large scale increase in agricultural productivity. This system came to be widely adopted after 1978 and was formally recognized by the Central Committee of the Party in 1984 on the condition that land continued to be owned by the collectives (see Wen,1991; Dong, 1995). Under HRS, village collectives are *de jure* owners of land which previously had been collectively farmed and typically lease land to households on 15 year contracts. The existing literature suggests that egalitarian allocation rules (which to some extent mimic the manner in which agricultural output was allocated to households on the basis of demographic composition during the collective period) have been adopted in the bulk of villages.

3.2 Base Regression Form

To study land allocation in our data we run regressions of the form:

$$A_h = \alpha + \sum_{j=1}^{J} \gamma_j n_j + \lambda n_{c>2} + \delta z + u \tag{1}$$

where A_h is the holding of cultivable land of the hth household, n_j are demographic classes and z are village dummies. The γ shown in Table 3 are therefore interpretable as the marginal area of land (measured in hectares) allocated to an individual of type j. Regressions also include dummies ($n_{c>2}$) for whether a household has more than two children to check whether increments of land associated with additional children decrease beyond this limit. Village dummies (z) are included to control for across village variation in unobservables which may affect the form of the land allocation rule.[13]

The first striking feature of the data is that there is close to universal access to land. To be exact, one household in Sichuan and ten households in Jiangsu are without cultivable land. Table 3 also provides clear evidence that land allocations resemble demogrants - that is transfers which are a function of a vector of demographic characteristics of the household (Deaton and Stern, 1986). 82% and 74% of the total variation in cultivable landholdings is explained by demographic variables and village dummies in Sichuan and Jiangsu respectively.

Allocation of land is also shown to be sensitive not only to household size but also to household composition. If land is allocated solely on the basis of household size, then γ coefficients would be roughly equal across demographic classes. F tests carried to check whether age classes could be pooled in the land allocation regressions rejected the validity of imposing these restrictions in all cases.[14] The hypothesis that land is allocated (solely) on the basis of the number of agricultural labourers in the household (see Wen, 1991) can also be rejected. Those not actively contributing to agricultural production are taken into account in the allocation of land.[15]

The overall form of the land allocation rules are strikingly similar across the two provinces. To aid comparison we can derive a land 'equivalence scale' (M), with allocations to farm adults serving as the reference class which can be normalised to unity. Allocations to children 0-4, 5-9 and 10-14 constitute about 0.23, 0.55-0.6 and 0.75-0.88 of transfers to farm adults respectively.[16] The elderly (55+) also receive similar treatment in the two provinces receiving an average allocation which is about 0.8-0.9 of that to farm adults.[17] Dummies for having more than two children in the household are negative and significant in the regressions for the two provinces (see Table 3) suggesting those having more than two children are penalised.

Taken together, these observations suggest that land may be allocated in line with the nutrition needs of households which are proxied by demographic composition.

3.3 Criteria for Allocation

Observed allocations observed reflect the outcomes of a complex bargaining process between village governments and member households. Given limited labour mobility and off-farm employment opportunities, the main concern of households may be to

[13] Village land quality and parameters of the contractual environment (e.g. grain quotas, land rent rates, land tax rates) can all be absorbed in this manner.

[14] Land is therefore not being allocated purely on a per capita basis.

[15] F tests reject exclusion of the young, the old and those engaged mainly in off-farm employment. This was even the case where we looked at a more disaggregated age breakdown including very young (0-1) and very old (70+) groups.

[16] This corresponds to individuals aged 0-4, 5-9 and 10-14 receiving 0.016-0.021, 0.041-0.050 and 0.062-0.069 hectares respectively. The lower bounds corresponding to Sichuan where there is lower aggregate availability of cultivable land.

[17] The allocation to the elderly is intermediate between that to children 10-15 and farm adults.

obtain sufficient land to satisfy nutritional needs.[18]

As a household level proxy of nutritional needs we can take the calorie equivalence scale developed by Burgess (1998b). Relative to standard Engel food share method (see Deaton and Muellbauer, 1986; Deaton, 1997) this measure has been shown to carry significant advantages with respect to identifying the nutritional needs of households primarilly because by focussing on calorie consumption as opposed to food expenditure it does not pick up the effects of quality related price variation.[19] Note that we are not we are not implying that village authorities are directly observing calorific needs and using this information in land allocation. Rather our supposition is that observed allocation rules which are based on household demographic composition function *as if* the authorities were allocating land in line with household nutritional needs.

The land equivalence scales for children 0-14, are 0.567 and 0.507 in Sichuan and Jiangsu respectively which are almost directly in line with the calorie equivalence scales, 0.576 and 0.522. This serves as preliminary evidence that land is being allocated in line with nutritional needs. If the nutritional hypothesis holds then land allocation should be done mainly on the basis of the number of adult equivalents (e) in a given household as determined by the calorie share method.[20] To get some sense of this, we compare two models; the base regression form, equation (1), and another where demographics have been replaced by the number of adult equivalents (e):

$$\begin{aligned} A_h &= \alpha + \sum_{j=1}^{J} \gamma_j n_j + \lambda n_{c>2} + \delta z + u \qquad (2) \\ A_h &= \alpha + \phi e + \lambda n_{c>2} + \delta z + u \end{aligned}$$

If allocation is done primarily on the basis of nutritional need then there should be no loss in information (fit) in moving between the two models. Results which are presented in column (2) of Table 3 suggest that this is roughly the case.We therefore have an indication that land is allocated on the basis of subsistence needs as proxied by e.[21]

[18] The observation of universal access to land suggests that subsistence concerns of all village households are being taken into account in the bargaining process. We therefore have a suggestion that democracy is better functioning in Chinese villages relative to the norm in other developing countries where the preferences of a large fraction of households are not taken into account in village level resource allocation decisions.

[19] Calorie based equivalence scales are thus closer to the notion of physiological or nutritional welfare which motivated the earliest work on equivalence scales though the method is not prescriptive and behavioural responses are taken into account (see Engel, 1895).

[20] Based on a 0-4, 5-9, 10-14, 15-55+ age breakdown there are 138 household types in Sichuan and 117 household types in Jiangsu each of which was assigned a unique equivalence scale. A 0001 household containing one adult was set as the numeraire and had a scale equal to unity. Scales calculated for other households are thus interpretable as adult equivalents.

[21] In Sichuan there is a tiny loss in fit in moving between the two models. The small loss in fit associated with moving from (1) to (2) in Jiangsu may be due in part to the fact that the e measure

3.4 Exogeneity

We turn now to the issue of whether the demogrants we observe are lump sum - i.e. they are not affected by the actions of individual household. If land transfers can be treated as exogenous then this adds considerable value as it allows us to trace out pure land effects on nutrition (whereas typically holdings of land and other household choice variables such as income are jointly determined). Two mechanisms might undermine the lump-sumness of land transfers. First, households may use reproduction to increase the size of landholdings. Second, more influential households may use their greater bargaining power to obtain larger landholdings than that which would be expected on the basis of demographic composition.

The first of these mechanisms is ruled out by the implementation of strict family planning policies. The relatively small sizes of households (4.35 for Sichuan and 4.15 for Jiangsu) demonstrate that constraints are being imposed on reproduction and that population growth is close to the replacement rate which would represent a stable equilibrium as regards the land allocation system. The fact that dummies for households containing three or more children are negative and significant suggests that controls on reproduction are introduced partly through the land allocation system itself as households containing more than two children are not allocated further increments of land.

The second of these mechanisms can be ruled out by examining whether households containing local or village government officials (which control the land allocation process) receive more land. To examine this possibility we create a dummy for whether a household contains a cadre or not. This specification is reported in column (3) of Table 3. The dummy is insignificant in both provinces offering a strong suggestion that households have limited ability to affect the amount of land they receive.

4 Land–Nutrition Linkages

As a prelude to this analysis we present in Table 5 tabulations of the main variables of interest arrayed by PCE decile. As would be expected from the land allocation rules described in Section 3 we find a highly egalitarian distribution of land across PCE deciles. If we take a conservative figure of 2100 calories per capita as our undernutrition cut-off (see United Nations, 1993) then it is apparent that undernutrition is mainly a threat to those in the bottom decile in Jiangsu and to those in the bottom two deciles in Sichuan. We contrast the Chinese figures with those taken from a similar expenditure survey for the state of Maharashtra in India in 1983 (Subramanian and Deaton 1993, 1996). Calorie availability for the poor appears to be considerably higher in rural China than it is in rural India despite similarities in GNP per capita

is not sensitive to outside earning opportunities whereas village authorities do appear to take this into account in allocating land.

(Table 1).[22] In essence, we have the impression from Table 4 that land allocation rules implemented in post-collective rural China put in place a *land floor* that prevents households from falling to calorie consumption levels which are prevalent in other countries.

We therefore now turn to the core issue of mapping out the pathways through which access to land can affect nutritional status in perfect and imperfect food market settings. The theory of land-nutrition linkages is provided in Section 4.1 and in Section 4.2 we use our household data to directly test the predictions generated by the theory.

4.1 Theory

A household is assumed to maximise a utility function:

$$u(x_c, x_m, x_l) \tag{3}$$

where the commodities are calories (x_c)[23], a non-food manufactured good (x_m) and leisure (x_l). Utility is maximsed subject to a full income constraint which captures the cash, time and production constraints facing the household:

$$p_c x_c + p_m x_m + w x_l = wT + \pi \tag{4}$$

where $\pi = p_c Q(L, \overline{A}) - wL$ where Q is production of the calories, $\overline{A}$ is land, L is total labour input and T is the aggregate time constraint which is treated as exogenous.[24]

Perfect Markets Case Calories and labour are provided by the family and eventually traded on the market. When markets exist for these commodities, they are considered homogenous, with perfect substitutability of domestic and market supply and with an exogenous price $(p_i = \overline{p})$.

The first order condition with respect to labour is:

$$\frac{\partial \mathcal{L}}{\partial L} = \lambda \left[p_c \frac{\partial Q}{\partial L} - w \right] = 0 \tag{5}$$

and therefore:

$$\frac{\partial Q}{\partial L} = \frac{w}{p_c} \tag{6}$$

[22] See United Nations (1993).Undernutrition typically affects the bottom 40% to 50% of the income distribution in India (see Osmani, 1991).

[23] Note that because we are abstacting from commodity heterogeniety concerns in the model, the terms food and calories can be used interchangeably as calories are just equal to food times a fixed conversion factor.

[24] This formulation is derived from the agricultural household model literature (Singh, Squire and Strauss, 1986; de Janvry, Fafcahmps and Sadoulet, 1991; Benjamin, 1992; Goetz, 1994).

Therefore labour (L) is independent of the choice of x_c, x_m, x_l. Labour demand is a function of prices (p_c, w), technology and landholding and utility maximisation is thus seperate from profit maximisation (see Benjamin, 1992). Separability between production and consumption decisions is the defining feature of the perfect markets case.

As a result, maximised profit (π^*) can be treated as exogenous to the households consumption decisions. Maximising utility with respect to the full income constraint it follows that demand for calories can be written as:

$$x_c = x_c(p_c, p_m, w, y^*), \text{ where } y^* = \pi^* + wT = y^*(\overline{A}, w, p_c) \tag{7}$$

and the effect of land on calorie consumption can be written as.

$$\frac{\partial x_c}{\partial \overline{A}} = \frac{\partial x_c}{\partial y^*}\frac{\partial y^*}{\partial \overline{A}} \tag{8}$$

This leads to our first result:

Result 1: *Under perfect markets land only has an effect on calorie consumption via its effect on income.*

Signing this effect is straightforward. The first term is positive by virtue of calories being a normal good. Given that T is assumed to be exogenous the second term is equivalent to $\frac{\partial \pi^*}{\partial \overline{A}}$. Writing out maximised profits as:

$$\pi^* = p_c Q[L^*(\overline{A};.), L] - wL^*(\overline{A};.) \tag{9}$$

and taking the total differential with respect to land we have:

$$\frac{\partial \pi^*}{\partial \overline{A}} = \frac{\partial L^*}{\partial \overline{A}}[\frac{p_c}{Q_L} - w] + p_c Q_A \tag{10}$$

from the first order condition with respect to labour we know that the first term is equal to zero so the overall effect of land on profits is $p_c Q_A$ which is positive. Therefore the overall effect of land on calorie consumption (operating through income) is positive.

Imperfect Market Case Household implicity face shadow prices for the home produced calories they consume (see Neary and Roberts, 1980). In the perfect markets case this is equal to the market prices and home produced and purchased calories are perfect substitutes. However, with imperfections in the calorie market (due to such factors such as quotas, risk associated with uncertain prices and availabilities, transportation costs, merchant mark-ups etc) buying prices (p_c^b)will tend to lie above selling prices (p_c^s) and shadow prices $(\widetilde{p}_c)$ which balance internal supply and demand may diverge from market prices (see Neary and Roberts, 1980; de Janvry, Fafchamps and Sadoulet, 1991). Endogeneity of shadow calorie prices introduces the possibility that they may be affected by household landholding thus introducing an additional own price effect in the relationship between land and calorie consumption.

To see this, consider the limiting case of a household where the calorie market is missing. Such a case may arise, for example, where the shadow calorie price falls between buying and selling prices ($p_c^s < \widetilde{p}_c < p_c^b$). (See Section 4.2 for a justification of this assumption in the context of rural China). The cost of a transaction through market exchange creates disutility greater than the utility it produces so that the household does not participate in the market. As a result the household has to equate calorie consumption with calorie production, the equibrilating factor being the shadow price of calories:

$$x_c(\widetilde{p}_c, p_m, w; \pi^*(\widetilde{p}_c, p_m, w, \overline{A}) + wT + E) = Q(\overline{A}, L(\overline{A}, \widetilde{p}_c^h, w)) \tag{11}$$

where $\widetilde{p}_c$ is the uncompensated shadow price of calories. Now when we take the differential of calorie demands (x_c) with respect to land:

$$\frac{dx_c}{d\overline{A}} = \frac{\partial x_c}{\partial y^*}\frac{\partial y^*}{\partial \overline{A}} + \frac{\partial c}{\partial \widetilde{p}_c}\frac{\partial \widetilde{p}_c}{\partial \overline{A}} \tag{12}$$

Result 2: *In incomplete food market settings access to land can affect calorie demand though two distinct mechanisms: (i) via an income effect, (ii) via an own price effect.*

To sign the second effect we use the fact that at the household's optimum utility level, Marshallian demand will be equal to Hicksian demand will be equated ($x_c = x_c^h$) and the compensated shadow price will be equal to the uncompensated shadow price:

$$\widetilde{p}_c^h(p_c^*, p_m, w, T, \overline{A}, \overline{u}) = \widetilde{p}_c(p_c^*, p_m, w, T, \overline{A}, E) \tag{13}$$

Using this equality we have that:

$$\frac{\partial \widetilde{p}_c^h}{\partial \overline{A}} = \left.\frac{\partial \widetilde{p}_c}{\partial \overline{A}}\right|_E + \frac{\partial \widetilde{p}_c}{\partial E}\frac{\partial e'}{\overline{A}} = \frac{d\widetilde{p}_c}{d\overline{A}} \tag{14}$$

where e' is the minimum exogenous income, E, needed to achieve utility $\overline{u}$. To sign the effect of land on the compensated shadow price we know that:

$$x_c^h(w, \widetilde{p}_c^h, p_m, \overline{u}) = Q(\overline{A}, L(\overline{A}, \widetilde{p}_c^h, w)) \tag{15}$$

taking the total differential and rearranging we have:

$$\left(\frac{\partial x_c^h}{\partial \widetilde{p}_c^h} - Q_L\frac{\partial L}{\partial \widetilde{p}_c^h}\right) d\widetilde{p}_c^h = \left(Q_A + Q_L\frac{\partial L}{\partial \overline{A}}\right) d\overline{A} \tag{16}$$

since the term in parenthesis on the left is unambigously negative while that on the left is unambigously positive it follows that $\frac{\partial \widetilde{p}_c^h}{\partial \overline{A}} < 0$ and hence that $\frac{d\widetilde{p}_c}{d\overline{A}} < 0$.

Result 3: *In incomplete food market settings the own price effect of having access to land is unambigously positive. Increasing access to land lowers the shadow price of calories and increases demand for calories.*

We can also look at *cross price* effects. Taking the differential of non-food demands with respect to land we have.

$$\frac{dx_m}{d\overline{A}} = \frac{\partial x_m}{\partial y^*}\frac{\partial y^*}{\partial \overline{A}} + \frac{\partial x_m}{\partial \widetilde{p}_c}\frac{\partial \widetilde{p}_c}{\partial \overline{A}} \tag{17}$$

The first term is the income effect which would be unambiguously positive. The second captures the effect of land which operates through the calorie shadow price. With perfect markets this second effect would not exist and land would only affect non-food consumption via the income effect. With a missing food market, we know that $\frac{d\widetilde{p}_c}{d\overline{\overline{A}}} < 0$ so that just need to sign the cross price effect $\frac{\partial x_m}{\partial \widetilde{p}_c}$. To do this we use a Slutsky decomposition:

$$\frac{dx_m}{d\widetilde{p}_c} = \frac{\partial x_m^h}{\partial \widetilde{p}_c} + \frac{\partial x_m}{\partial y^*}x_c \tag{18}$$

the second term is unambigously positive.[25] The overall sign of compensated non-food demands with respect to the shadow calorie price is ambiguous. If we consider food and non-food consumption to be broadly substitutable then we would expect this effect and hence the overall *cross-price* effect to be positive (see Singh, Squire and Strauss, 1986).[26] This yields the following testable prediction.

Result 4: *With an incomplete food market and controlling for the income effect we would expect increasing access to land, which lowers the shadow calorie price, to have a negative impact on non-food consumption and a positive impact on food consumption.*

Similarly, if we were to extend the model to allow for a distinction between purchased calories (x_c^p) and own produced calories (x_c^o) then access to land will affect purchased calorie consumption both through an income effect and by affecting the shadow price of own produced calories ($\widetilde{p}_c$).[27]

$$\frac{dx_c^p}{d\overline{A}} = \frac{\partial x_c^p}{\partial y^*}\frac{\partial y^*}{\partial \overline{A}} + \frac{\partial x_c^p}{\partial \widetilde{p}_c}\frac{\partial \widetilde{p}_c}{\partial \overline{A}} \tag{19}$$

[25] Assuming x_m is a normal good.

[26] In this specific case the overall impact of land on non-food consumption will depend on whether the income or subsitution effect dominates.

[27] A household may have a shadow price that falls in the $p_c^s < \widetilde{p}_c < p_c^b$ region but may be forced to purchase some calories because its land endowment (A) is insufficient to meet calorie requirements. This seems to conform with what is observed for households with low land endowments in the Chinese data. Thus it is not that we are ruling out a food market but rather pointing out that a large number of households would not voluntarily choose to participate in such a market.

The latter effect would not exist for the perfect markets case. The cross-price effect can again be written as a Slutsky decomposition:

$$\frac{dx_c^p}{d\widetilde{p}_c} = \frac{\partial x_c^{hp}}{\partial \widetilde{p}_c} + \frac{\partial x_c^p}{\partial y^*} x_c^o \tag{20}$$

The second term will be unambiguously positive. Own produced and purchased calories are close substitutes so we would expect the derivative of Hicksian demands for purchased calories to be positive with respect to the shadow or internal price of own produced calories ($\widetilde{p}_c$). This yields another testable prediction.

Result 5: *Controlling for the income effect we would expect increasing access to land, by lowering the shadow price of food, to have a negative impact on purchased calorie consumption and a positive effect on own produced calorie consumption.*

4.2 Empirical Testing

Using the polar perfect and imperfect market cases of the simplest household model we have been able to derive a number of useful results. Our purpose here is to subject these results to econometric testing using household data. Several considerations would make us suspect that the market for food in rural China is highly incomplete. The transition to a market based system only began in 1978 and prior to that villages were mainly self-sufficient in food and trade was primarilly rural-urban (see Sah and Stiglitz, 1992). The grain procurement system is still in place and results in a large gap between buying and selling prices. We observe households responding to these adverse market conditions by relying mainly on own production to satisfy their calorie requirements. For example, if we take the relatively homogenous grain category from which households derive the bulk of their calorie needs[28], we observe that calories from home production account for 95% of total grain calories in Jiangsu and 88% in Sichuan. The fact that we observe richer households with higher land endowments exiting the market would suggest that, in aggregate, lower land endowments force more households in Sichuan to use the market to make up the calorie shortfall from home production (once the quota has been satisfied).[29] These observations are consistent with the shadow calorie price lying below the free market buying price ($\widetilde{p}_c < p_c^b$). On the selling side we find that whilst most households are net sellers of grain, however, the bulk of sales are to the government[30]. Sales to the free market are relatively modest: expressed in calorie terms they represent 21% of total consumption in Jiangsu and 7% in Sichuan. These observations are consistent with the shadow calorie price

[28] 81% of calorie consumption in Sichuan and 75% in Jiangsu.

[29] In Jiangsu 68% record zero purchases of grain on the free market whereas the corresponding figure for the poorer province, Sichuan, is 44%.

[30] 70% in the case of Jiangsu and 74% in the case of Sichuan.

lying above the average selling price ($\tilde{p}_c > p_c^s$). Overall we get the impression of a continuum of semi-autarkic households who only enter the buying side of the market when forced to do so by production constraints and who only enter the selling side when subsistence requirements have been met and there is a need to satisfy non-food demands or to diversify tastes. The bulk of households can be characterised as being in the region $p_c^s < \tilde{p}_c < p_c^b$ where own price effects may be an important part of the story of how access to land might affect nutritional status. Due to lesser market integration, we would also expect, the width of the band between p_c^b and p_c^s to be larger in the poorer province Sichuan and hence the own price effect to be stronger.

4.2.1 Basic Results

We turn now to empirically testing for the different predictions of the theory as regards how access to land might affect nutritional status. Let us begin with a standard calorie demand equation (see Subramanian and Deaton, 1996):

$$\ln(x_c/n) = \alpha + \beta \ln(x/n) + \eta \ln(n) + \sum_{j=1}^{J-1} \gamma_j (\frac{n_j}{n}) + \sum_{k=1}^{K-1} \gamma_k (\frac{n_k}{n}) + \delta z + u \tag{21}$$

where x_c is calorie consumption, x is total expenditure, n is household size, n_j are demographic classes and n_k are numbers of adults engaged in primary, secondary and tertiary employment and z are village dummies. Results for this baseline specification are presented in column (1) of Table 5. Calorie expenditure elasticities are positive and significant in both provinces and the positive association between income and nutrition is stronger for the poorer province (see Section 5).[31] The impact of demographics and occupation seem plausible; increasing household size and increasing the proportion of children in the household tends to reduce demand for calories whereas increasing the share of household labour involved in a primary occupation tends to increase calorie demands.

We then draw on the central finding from Section 3 that the process generating the distribution of land is independent from that generating the distribution of income. This condition, which is not satisfied in most developing countries, allows us to directly include land (A) in the calorie demand equation:[32]

$$\ln(x_c/n) = \alpha + \beta \ln(x/n) + \zeta \ln(A/n) + \eta \ln(n) + \sum_{j=1}^{J-1} \gamma_j (\frac{n_j}{n}) + \sum_{k=1}^{K-1} \gamma_k (\frac{n_k}{n}) + \delta z + u \tag{22}$$

Given that land affects income but not vice versa the income effect of land on nutrition should be captured in the (x/n) term and the coefficient on (A/n) captures the own

[31] The calorie-expenditure elasticity for Sichuan is 0.31 wheras the corresponding figure for Jiangsu is 0.20.

[32] The $(x/n)^2$ term is included to take some account of the non-linear relationship between nutrition and income (see Section 5). Adding a cubic term did not improve the fit of the relationship.A quadratic term for land was insignificant in both provinces.

price effect. Results are presented in column (2) of Table 5. The coefficient on per capita land (A/n) is consistently positive and significant in both provinces, even though per capita expenditure (x/n) is being controlled for.[33] Using Results 1 and 2 from the previous section this suggests we are in an incomplete market setting where access to land can affect calorie demand *via* both income and own price effects. The fact that the effect is positive and significant is also in line with interpreting it as an own price effect - increasing access to land lowers the shadow price of calories and increases demand for calories (see Result 3).

Comparing across provinces, we observe that the A/n effect is larger in the poorer, less market integrated province, Sichuan. In this province, the elasticity of calories with respect to land is 0.13 whereas the corresponding figure for Jiangsu is 0.09. This is in line with the theoretical prediction that the magnitude of the own-price effect will diminish with market development to the point that it no longer exists under perfect markets (see Results 1 and 2). Essentially as the size of the price band between buying and selling prices diminishes so does the value of having access to land as a source of cheaper calories. Negative correspondence between the magnitude of the effect and degree of market development is consistent with interpreting the A/n effect as an own price effect.

One problem we have in interpreting the coefficient on land as an own price effect is that our control income for income (x/n) is a short run measure and is likely to be an imperfect proxy of permanent income. Land may just be picking up the effects of omitted correlates of permanent income on calorie consumption. To circumvent this problem we first regress the variable measured with error (x/n) on a set of variables that are likely to be correlated with the permanent income of the household:

$$\ln(x/n) = \gamma_1 D_h + \gamma_2 E_h + \gamma_3 A_h + \gamma_4 C_h + \epsilon \tag{23}$$

where (D_h) are demographic variables, (E_h) are educational and occupational status variables, (A_h) are stocks of physical assets (including land), (C_h) are community or environmental characteristics such as access to amenities and location dummies.[34] These variables thus represent longer term characteristics of the household which have bearing on the determination of permanent income and are likely to be measured with less noise than income or expenditure. Results from this regression are shown in Table A1 in Appendix 1. The fitted value from this regression, $\ln(\widehat{x/n})$ is used at the second stage in place of $\ln(x/n)$ in a regression explaining calorie intake (column (3) of Table 5). Landholding remains positive and significant at the second stage, the size of the nutrition-land elasticities are largely unchanged with a larger value

[33] The results did not change in any significant way when income was used in the place of expenditure.

[34] This type of formulation is consistent with household production theory where in a rural setting physical asset stocks might include both monetary (e.g. savings) and non-monetary components (e.g. land, grain stocks, housing, household durables, productive assets - see Singh, Squire and Strauss, 1986).

still being recorded for the poorer province, Sichuan, where markets have developed the least thus confirming our earlier results.[35] Finally, we worry about the fact that land may be associated with non-linearities in the relationship between income and nutrition by including quadratic terms in for $\ln(\widehat{x/n})$ and $\ln(\widehat{x/n})$ and again find that the land effects are robust to these specifications.[36]

The two stage procedure described above can also be used to obtain estimates of both income and own price effects and hence to compare their magnitude across provinces. The empirical counterpart of the equation that decomposes the total effect of land on nutrition into these two effects can be written as:

$$\frac{d\ln(x_c/n)}{d\ln(A/n)} = (\frac{\partial\ln(x_c/n)}{\partial\ln(\widehat{x/n})}) * (\frac{\partial\ln(\widehat{x/n})}{\partial\ln(A/n)}) + \left.\frac{\partial\ln(x_c/n)}{\partial\ln(A/n)}\right|_{(\frac{x}{n})} \tag{24}$$

where the product of the first two terms is the income effect and the third term we interpret as the own price effect. This own price effect is large compared to the income effect. As shown in Table 6, the own price effect is over seven times the income effect in Sichuan, and over four times the income effect in Jiangsu. Thus the dominant route through which land influences calorie availability in the two provinces is through the own price effect. Land in rural China appears to be of value to nutritional welfare primarily by acting as a source of cheaper calories relative to the market. Given this cost difference and the fact that there may be an element of risk in depending on markets, most households satisfy the bulk of their calorie demands from own production. Under these semi-autarkic conditions it is clear that having access to the means to produce calories has a value (in terms of nutritional attainment) that exceeds the value of the output produced. With incomplete markets, land distribution, if politically feasible, may be a more effective public intervention than the distribution of food itself.

4.2.2 Further Robustness Checks

Under complete markets prices are exogenous and land only affects consumption *via* income. Incomplete external food markets lead to an internal food market where the calorie price is endogenous and thus generate another route through which land can affect consumption. Results 4 and 5 from the theory section demonstrate how this effect will be different depending on whether consumption is directly linked to production from land. Thus if the A/n effect we observe in regressions where income is separately controlled for is to be interpreted as an own price effect then we would expect its sign to be different for food and non-food consumption (Result 4) and home produced and purchased calorie consumption (Result 5). In contrast, if A/n is just correlated with omitted wealth or status variables which affect food or calorie

[35] The elasticity is 0.15 for Sichuan and 0.10 for Jiangsu.

[36] Results not reported. Quadratic terms for land, $(\ln(A/n))^2$, turn out to be insignificant in the regressions and are not included.

consumption but which are not captured in $\ln(\widehat{x/n})$ then we would expect the sign of land effects on different types of consumption to be the same. Breaking out consumption into these elements provides us with a clean way of distinguishing between these hypothesis and provides us with another battery of robustness checks for the main results reported in Table 5.

Results are shown in Table 7 for a specification where income is controlled for using instrumented expenditure ($\ln(\widehat{x/n})$) and instrumented expenditure squared $(\ln(\widehat{x/n}))^2$.[37] Columns (1) and (2) show the food and non-food expenditure regressions. In line with Result 4 we find that coefficient on land is positive and significant for the food expenditure equation (column 1) and negative and significant for the non-food expenditure equation (column). Expanding access to land thus appears to increase food consumption per capita *via* an own price effect and decrease non-food consumption *via* a cross price effect. This is consistent with us being in an imperfect food market setting as neither of these price effects would operate in a perfect markets setting where prices were exogenous. They also jointly suggest that land is not picking up omitted wealth effects which would act to both increase consumption of both food and non-food. In columns (3) and (4) we take the relatively homogenous grain category and contrast land effects on home produced and purchased calorie consumption. In line with Result 5 we find that the sign of the land effect switches, being positive for home produced grain calories and negative for purchased grain calories. Exactly the same pattern of results obtain when we use uninstrumented total expenditure ($\ln x/n$) as our income control or include quadratic terms for either $\ln x/n$ or $\ln \widehat{x/n}$. Although the left hand side variables in these regressions have no welfare interpretation, the pattern of effects observed bolsters our confidence that the land effect in the main calorie regressions reported in Table 5 can be interpreted as own price effects.

5 Conclusions

At the core of this paper is an attempt to study how land allocation by nonmarket village institutions affects nutritional status. We find that as a result of this nonmarket allocation the process generating the distribution of land in rural China is independent from that generating the distribution of land. This provides us with a clean test of the seperation hypothesis and allows us to trace out the pathways through which access to land affects nutritional status. Our results strongly suggest that food markets are incomplete and food production and consumption decisions are linked though an endogenous price ($\widetilde{p}_c$).

We show that, in these incomplete food market settings, redistribution of land will have a larger impact on nutritional welfare than redistribution of output or income from that same land (but where land distribution is held constant). In these settings

[37] Including a quadratic term, $(\ln \widehat{x/n})^2$, did not affect the results in any significant way.

there is a sense in which asset redistribution will be a more effective welfare policy than cash or in-kind redistribution because of the added benefit of having access to a cheaper source of calories.

China's welfare achievements can thus be linked to the operation of a particular set of village land institutions. The fact that these nonmarket institutions, under incomplete or missing markets settings and with limited intervention by central government, have managed *via* localised redistribution to produce a record in terms of the prevention of undernutrition that exceeds that of all low income countries is another striking finding of the paper. This suggest that the Chinese approach to nutrition which focuses on *ex ante* redistribution of opportunity as opposed to *ex post* consumption smoothing deserves greater study in other contexts (in particular in areas where high income growth cannot be guaranteed).

Our results should not, however, be taken to suggest that the overall allocation of resources is optimal. There is excessive dependence on agriculture and aggregate welfare and production is not being maximised. This points to the need to remove market imperfections which are preventing households from utilising their endowments fully. We have in this paper been able to isolate particular features of the current system which are advantageous from the perspective of achieving adequate nutrition. Recent calls to base land allocation on performance as opposed to household composition as a means of enhancing overall production efficiency run the danger of not taking proper account of the equity and social protection features of the current system. We believe that these reforms should be opposed unless measures to compensate those who are made nutritionally vulnerable can be devised. Given the numbers of individuals involved (~800 million), these are matters that should not be taken lightly.

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Table 1: Welfare Indicators in China and India, 1990

	CHINA	INDIA
GNP per Capita	410	370
Daily calorie supply	2630	2238
Children 0-5 below -2 s.d. weight for age	17.4	63.9
Children 0-5 below -2 s.d. height for age	31.4	62.1
Infant mortality rate	31	97

Source: World Bank (1993), United Nations (1993), World Health Organisation (1997).

Table 2: Sample Characteristics, Rural Sectors, 1990

	Sichuan	Jiangsu
Rural PCE (yuan)	569	953
Rural PCI (yuan)	504	883
Rural industry/ rural output (%)	26.9	60.4
Location	Central inland	East coastal
Climate	Subtropical	Subtropical
Main food crop	Rice	Rice
Household size	4.35	4.15
Sample size {counties} [villages] <household> (persons)	 {54} [538] <5380> (23416)	 {34} [336] <3364> (13920)

Source: SSB Rural Household Surveys. China Statistical Yearbook (1991).

Table 3: Land Allocation and Nutritional Need
Dep. Var: Household Cultivable Land (hectares)

	Rural Sichuan			Rural Jiangsu		
	(1)	(2)	(3)	(1)	(2)	(3)
Intercept	0.060 (6.64)	-0.003 (0.36)	0.060 (6.64)	0.083 (7.09)	0.007 (0.46)	0.083 (7.09)
No. eq. adults		0.104 (31.98)			0.133 (24.54)	
Cadre dummy			0.007 (1.31)			-0.009 (0.89)
0-4N	0.016 (5.07)		0.016 (5.09)	0.021 (3.62)		0.021 (3.61)
5-9N	0.041 (13.33)		0.041 (13.31)	0.050 (9.73)		0.050 (9.72)
10-14N	0.062 (20.76)		0.062 (20.66)	0.069 (12.92)		0.069 (12.90)
15-54N Farm	0.070 (31.17)		0.070 (30.98)	0.092 (25.71)		0.092 (25.68)
15-54N Off-farm	0.056 (20.72)		0.056 (20.35)	0.054 (15.66)		0.054 (15.68)
55+N	0.064 (23.03)		0.064 (22.96)	0.076 (15.06)		0.076 (15.06)
Dummy for >2 children	-0.022 (2.24)	-0.039 (4.04)	-0.022 (2.22)	-0.024 (2.21)	-0.030 (2.51)	-0.023 (2.21)
Sample size	5379	5379	5379	3354	3354	3354
Adj. R^2	0.8170	0.8172	0.8172	0.7358	0.7071	0.7358

Notes: All regressions are reported with robust (Huber) standard errors. Absolute t statistics in parenthesis. N indicates that demographics are expressed in terms of numbers of people in the different age groups. Adults (15-55) are divided according to whether they list their primary employment as being on or off-farm. Regressions also contain dummies for 537 villages (clusters) in Sichuan and 336 villages (clusters) in Jiangsu.

Table 4: Calorie Availability by Per Capita Expenditure (PCE) Decile: China and India

PCE decile	Per capita calorie availability			Per capita cultivable land		Per capita expenditure means	
	RS	RJ	RM	RS	RJ	RS	RJ
1	1772	2046	1429	0.066	0.083	284	347
2	2024	2245	na	0.068	0.091	354	473
3	2170	2450	na	0.073	0.092	400	555
4	2301	2479	na	0.072	0.091	442	633
5	2393	2513	na	0.078	0.090	485	714
6	2480	2612	na	0.074	0.095	532	804
7	2624	2675	na	0.077	0.094	586	920
8	2683	2787	na	0.082	0.097	654	1081
9	2834	2784	na	0.079	0.097	769	1321
10	3140	3057	3167	0.081	0.087	1156	2556
All	2442	2565	2120	0.075	0.092	566	941

Notes: Calorie availability for rural Sichuan (RS) and rural Jiangsu (RJ) is computed from SSB Rural Household Surveys, 1990. The source of the calorie figures for rural Maharashtra (RM) is Subramanian and Deaton (1993); na means not available. Per capita land refers to the mean per capita land holding for households in the relevant decile or deciles. Land is measured in hectares. PCE is measured in 1990 yuan. The computations are based on 5379 households for Sichuan and 3354 households for Jiangsu.

Table 5: Access to Land and Nutritional Status: Basic Results

	Rural Sichuan			Rural Jiangsu		
	log per capita calories	log per capita calories	log per capita calories	log per capita calories	log per capita calories	log per capita calories
	(1)	(2)	(3)	(1)	(2)	(3)
	OLS	OLS	IV	OLS	OLS	IV
log per capita land		0.131 (12.09)	0.148 (11.61)		0.092 (6.45)	0.098 (6.10)
log per capita expenditure	0.311 (27.48)	0.298 (27.30)		0.198 (20.31)	0.189 (19.48)	
instrumented log per cap exp			0.231 (14.88)			0.153 (8.96)
log household size	-0.119 (13.10)	0.100 (11.31)		-0.195 (14.80)	-0.184 (14.20)	
Adj. R^2	0.741	0.757	0.648	0.619	0.630	0.562
no. obs.	5379	5379	5379	3354	3354	3354

Notes:All regressions are reported with robust (Huber) standard errors. Regressions also contain controls for the occupational status and demographic composition of households and dummies for 537 villages (clusters) in Sichuan and 336 villages (clusters) in Jiangsu.

Table 6: Decomposition of Land Effect on Calorie Availability

Province	$d$lnPCCAL/ $d$lnPCLAND (1) x (2) + (3)	∂lnPCCAL/ ∂lnPCE (1)	∂lnPCE/ ∂lnPCLAND (2)	∂lnPCCAL/ ∂lnPCLAND (PCE constant) (3)
Sichuan	0.1535	0.2503	0.0938	0.1300
Jiangsu	0.1062	0.1727	0.1366	0.0826

Notes: (2) is obtained from the first stage regression for 2SLS (Table A1) and (1) and (3) are obtained from the second stage regression (Table A2).

Table 7: Access to Land and Consumption: Robustness Checks

	Rural Sichuan				Rural Jiangsu			
	log per capita food exp	log per capita non-food exp	log per capita own prod grain cal	log per capita purch grain cal	log per capita food exp	log per capita non-food exp	log per capita own prod grain cal	log per capita purch grain cal
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
	IV	IV	IV	IV	IV	IV	IV	IV
log per capita land	0.098 (6.21)	-0.065 (2.05)	0.299 (11.10)	-0.237 (2.30)	0.109 (4.97)	-0.086 (2.33)	0.329 (9.52)	-0.886 (5.36)
instrum log p.c. exp	2.751 (7.35)	5.361 (4.99)	0.568 (1.20)	6.091 (2.65)	0.397 (0.78)	3.608 (3.89)	0.228 (0.67)	-1.557 (0.60)
instrum log per cap exp sq.	-0.181 (6.22)	-0.290 (3.44)	-0.040 (1.09)	-0.451 (2.53)	-0.006 (0.17)	-0.153 (2.24)	-0.013 (0.53)	0.143 (0.75)
log hh size	-0.124 (8.65)	0.188 (6.61)	-0.060 (3.51)	-0.351 (4.04)	-0.226 (10.55)	0.234 (6.13)	-0.167 (5.85)	-0.488 (3.12)
Adj. R^2	0.639	0.520	0.708	0.517	0.590	0.584	0.681	0.422
no. obs.	5379	5379	5379	5379	3354	3354	3354	3354

Notes: Absolute t statistics in parenthesis. All regressions are reported with robust (Huber) standard errors. Regressions also contain controls for the occupational status and demographic composition of households and dummies for 537 villages (clusters) in Sichuan and 336 villages (clusters) in Jiangsu.

Table A1 : First Stage for 2SLS Estimation of Land-Nutrition Relationship
Dependent Variable: Ln (PCE)

	Rural Sichuan		Rural Jiangsu	
	Estimate	t	Estimate	t
Intercept	2.943	3.761	6.010	17.465
Household characteristics				
Ln household size	-0.320	8.138	-0.241	3.834
F0-4p	-0.277	4.723	-0.543	5.637
M0-4p	-0.195	3.391	-0.470	4.885
F5-14p	0.074	1.516	0.047	0.540
M5-14p	0.083	1.773	0.068	0.846
M15-54p	-0.044	1.360	0.048	0.824
M55+p	-0.037	0.723	0.030	0.348
M55+p	-0.160	3.474	-0.111	1.600
Primaryp	-0.108	3.319	0.007	0.145
Secondaryp	0.203	3.847	0.092	1.562
Tertiaryp	0.312	5.307	0.222	2.979
No. wage earners	0.134	4.096	0.508	0.508
Characteristics of household head				
Sex	0.039	2.511	0.030	0.968
Age	1.422	3.341	-0.083	0.459
$(Age)^2$	-0.185	3.191	0.010	0.388
Education	0.018	5.853	0.011	2.2129
$(Education)^2$	-0.001	5.974	-0.001	2.249
Housing characteristics				
House purchase	0.504	24.128	0.661	25.871
Electricity	0.035	2.304	0.078	3.168
Ln houses PC	0.002	2.306	0.002	0.939
Ln floor area PC	0.001	0.474	-0.001	0.531
Proportion concrete	0.169	5.522	0.062	1.706
Ownership of durables				

Ln Bicycle PC	0.178	5.687	0.086	2.122
Ln Sewing machine PC	-0.022	0.515	0.011	0.214
Ln Clock PC	0.097	1.877	0.133	2.733
Ln Watch PC	0.136	7.567	0.177	4.988
Ln Fan PC	0.232	5.889	0.157	3.802
Ln Washing machine PC	0.084	0.748	-0.040	0.442
Ln Fridge PC	0.086	0.174	0.838	3.364
Ln Motorcycle PC	0.467	1.337	-0.012	0.068
Ln Furniture PC	0.058	8.188	0.021	1.685
Ln Radio PC	-0.024	0.655	0.048	0.980
Ln B/W TV PC	0.398	10.257	0.265	4.493
Ln Colour TV PC	0.576	3.483	0.399	2.972
Ln Tape recorder PC	0.138	2.611	-0.056	0.758
Ln Camera PC	-0.387	1.163	0.480	1.734
Access to land/water				
Ln land PC	0.094	8.446	0.137	7.864
Ln hilly field PC	0.000	0.056	0.000	1.831
Ln water PC	0.001	2.562	0.001	1.811
Productive assets				
Ln Motor vehicle PC	0.095	2.242	0.089	0.427
Ln Tractor PC	-0.020	1.247	-0.012	0.012
Ln Thresher PC	0.039	1.884	0.020	1.473
Ln Cart PC	-0.005	0.394	0.001	0.810
Ln Pump PC	-0.011	0.948	-0.012	0.584
Ln Motor boat PC	-0.664	2.155	-0.021	0.717
Ln Draught animal PC	0.005	3.242	-0.000	0.057
Sample size	5379		3354	
Adj. R^2	0.496		0.534	

Notes:All regressions corrected for heteroscedasticity (Huber standard errors). All variables which are not in proportions are expressed in log form.

Table A2: Second Stage for 2SLS Estimation of Land-Nutrition Relationship
Dependent Variable: Ln (PCCAL)

	Rural Sichuan		Rural Jiangsu	
	Estimate	t	Estimate	t
Intercept	5.715	60.366	6.479	55.683
Ln (PCE)*	0.250	17.531	0.172	10.567
Ln household size	-0.098	10.651	-0.173	13.761
Ln per capita land	0.130	18.786	0.083	8.883
Primaryp	0.117	7.097	0.107	4.846
Secondaryp	0.031	0.982	0.119	4.265
Tertiaryp	-0.030	0.862	0.121	3.265
F0-4p	-0.134	3.893	-0.267	5.478
M0-4p	-0.216	6.501	-0.246	5.166
F5-14p	0.002	0.065	0.004	0.096
M5-14p	0.028	1.020	0.009	0.222
M15-54p	-0.010	0.571	-0.027	1.013
M55+p	0.052	1.996	-0.054	1.647
F55+p	0.025	0.979	0.084	2.371
Sample size	5379		3354	
Adj. R^2	0.393		0.330	

Notes:All regressions corrected for heteroscedasticity (Huber standard errors). PCE* refers to fitted values of PCE using the regression shown in Table A1. Variables ending with p are expressed as a proportion of household size (demographics) or household labour force (employment status). Primary, Secondary and Tertiary refer to sector of employment of adult household members. 0-4, 5-14, 15-54, and 55+ are age classes, while the suffixes M and F refer to gender. The equations also include county dummies, 33 in Jiangsu and 53 in Sichuan.