Online Appendix to the Paper *Can Rationing Increase Welfare in Developing Countries? Theory and An Application to India's Ration Shop System*

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A1.1 Ration shop systems as redistribution policy

This sub-section provides proofs for the propositions and statements in sub-section II.B in the paper.

Optimal linear rate

The optimal linear rate is found by taking the derivative of W with respect to t:

$$\frac{\partial W}{\partial t} = -\int_i \frac{\partial G}{\partial v_i}\frac{\partial v_i}{\partial z}di + \mu(x + t\int_i \frac{\partial x_i}{\partial z}di)$$

Using Roy's identity and re-arranging gives:

$$\frac{t}{z+t} = \frac{(\mu - g)x - \int_i (g_i - g)x_i di}{-\mu\epsilon x} \tag{A1}$$

Using the fact that $g = \pi g_p + (1-\pi)g_{np}$, $x = \pi x_p + (1-\pi)x_{np}$ and $\alpha = \frac{x_p}{x}$ we can write

$$\int_i (g_i - g)x_i = (g_p - g_{np})\pi x(\alpha - 1) \tag{A2}$$

Plugging in (A2) in (A1) gives expression (2) in the paper.

Proof of propositions 1

Consider now the impact of introducing a ration shop system. The welfare effect of a small increase in tax dt_2 above q is:

$$dW_2(q) = -\int_{x_i \geq q} g_i(x_i - q)di + \mu(x_2 - q)(1 - H(q)) + \mu\frac{t}{z+t}(\epsilon_2 x_2 + \eta_2 s_2 q)(1 - H(q)) \tag{A3}$$

The effect of a small decrease in tax dt_1 above q is:

$$dW_1(q) = \int_{x_i < q} g_i x_i di + \int_{x_i \geq q} g_i q di - \mu(x_1 H(q) + q(1 - H(q))) + \mu\frac{t}{z+t}(-\epsilon_1 x_1 H(q) + \eta_2 s_2 q(1 - H(q))) \tag{A4}$$

Plugging in the expression for $\frac{t}{z+t}$ and re-arranging we obtain $dW_2 = dW_1$.

To obtain expression expression (3) in the paper note that we can write

$$\int_{x_i \geq q} (g_i - g)x_i di = (g_p - g_{np})x_2(1 - H(q))(\pi_2\alpha_2 - \pi) \tag{A5}$$

Plugging in (A2) and (A5) in (A3), re-arranging and scaling by $(1-H(q))(x_2-q)$ we obtain expression (3).

Implications of proposition 1

Proof that the redistribution effect is positive if the good is normal.
If demand for the good is increasing with income we have $\pi > \pi_2$, $\alpha \geq \frac{x_{2p}(q)}{x_2(q)}$ and $x_{2p} < x_2$. These three inequalities together imply:

$$\pi\alpha > \pi_2(q)\frac{x_{2p}(q) - q}{x_2(q) - q} \tag{A6}$$

This and $g_p > g_{np}$ imply that the redistribution effect of introducing a RSS for a normal good is positive.
Proof that the total welfare effect is negative for a luxury good.
Consider a good that the poor consume very little off, such that $x_{2p}(q)$ and $\pi_2(q)$ are negligible, and α is low. We can show that there is a value $\bar{\alpha}$ such that if $\alpha < \bar{\alpha}$ the total welfare effect $dW^R(q)$ is negative. To see this, replace for the optimal rate (2) in expression (3), set $x_{2p}(q)$ and $\pi_2 q$ equal to 0 and $\epsilon = \epsilon_2(q)$. We obtain:

$$dW^R(q) = -\frac{\epsilon_2^c(q)}{\epsilon(\theta - 1)}(g_p - g_{np})\pi(1 - \alpha) + (g_p - g_{np})\pi\alpha \tag{A7}$$

Reorganizing we can show that $dW^R(q) < 0$ if $\alpha < \bar{\alpha}$ where:

$$\bar{\alpha} = \frac{\epsilon_2^c(q)(g_p - g_{np})\pi}{\epsilon_2^c(q) + \epsilon(\theta - 1)} \tag{A8}$$

A1.2 Ration shop systems as insurance against price risk

This sub-section provides proofs for the propositions and statements in sub-section II.C in the paper.

Proof of proposition 2

To obtain expression (4) in the paper take the derivative of Roy's identity ($v_{yi}x_i = -v_{zi}$) with respect to income and re-arrange, using $r = -\frac{v_{yyi}y_i}{v_y}$ and $s_i = \frac{x_i(\bar{z}+t)}{y_i}$.

To understand the welfare effect of introducing a ration shop system in the presence of price risk I consider the expected value of price-indexed taxes and transfers by taking first-order linear approximations. Consider first the welfare impact of introducing a piecewise increasing tax in a world with price risk. The impact of an extra tax dt on consumption of the good can be written as (taking a linear approximation of $v_i(y_i, z+t+dt)$ around $v_i(y_i, z+t)$):

$$v_i(y_i, z+t+dt) = v_i(y_i, z+t) + v_{zi}(y_i, z+t)dt = v_i(y_i, z+t) - v_{yi}(y_i, z+t)x(y_i, z+t)dt \tag{A9}$$

Taking expectations across all states of the world and using (4) we obtain:

$$E(v_i(y_i, z+t+dt)) = E(v_i(y_i, z+t)) - v_{iy}x_i(1+\epsilon s_i(r-\eta)\sigma^2)dt, \tag{A10}$$

where v_{yi}, x_i and s_i are evaluated at $z = \bar{z}+t$. This implies that the marginal social welfare cost from levying a tax dt on household i is $g_i x_i(1+\epsilon s_i(r-\eta)\sigma_z^2)dt$ as opposed to $g_i x_i dt$ in a world without price risk. The welfare cost of taxation is thus decreasing in the level of price risk σ, which implies that optimal linear taxes will be increasing in price risk. Formally, the optimal linear tax rate is now given by:

$$\frac{t^{**}}{z+t^{**}} = \frac{(\mu - g) + (g_p - g_{np})\pi(1-\alpha) - \epsilon\sigma^2(r-\eta)\int g_i x_i s_i di}{-\mu\epsilon}, \tag{A11}$$

Turning now to the price stabilization component of the RSS, consider households consuming more than q. They receive a transfer $(z-\bar{z})q$ whose impact on utility is obtained by taking a linear approximation of $v_i(y_i + (z-\bar{z})q, z+t)$ around $v_i(y_i, z+dt)$, using (4) and taking expectations:

$$E(v_i(y_i + q(z-\bar{z}), z+t)) = E(v_i(y_i, z+t)) + v_{yi}qs_i(r-\eta)(\bar{z}+t)\sigma^2. \tag{A12}$$

The marginal social welfare effect of transferring $(z-\bar{z})q$ to household i consuming at least q is thus given by $g_i q s_i(r-\eta)(\bar{z}+t)\sigma^2 > 0$.

Finally households consuming less than q are faced with a fixed price $\bar{z}$. The impact on their utility is obtained by taking a linear approximation of of $v_i(y_i, \bar{z}+t)$ around $v_i(y_i, z+t)$, taking expectations and using assuming the distribution is symmetric ($E(z-\bar{z})^3 = 0$):

$$E(v_i(y_i, \bar{z}+t)) = E(v_i(y_i, z+t)) + v_{iy}(s_i(r-\eta)+\epsilon)x_i(\bar{z}+t)\sigma^2. \tag{A13}$$

Summing across all households and scaling by $(x_2 - q)(1 - H(q))$ gives expression 5 in the paper.

A1.3 Extensions

Results for general government preferences

In this sub-section I no longer assume that there are only two social welfare weights g_p and g_{np} and instead let household i's weight g_i be undefined expect for the assumption $\frac{\partial g_i}{\partial y_i} \leq 0$. The optimal linear rate can be written as:

$$\frac{t^*}{z+t^*} = \frac{(\mu - g) - \int_i (g_i - g)\frac{x_i}{x} di}{-\mu\epsilon} \tag{A14}$$

The interpretation of this expression is the same as that of expression (2). In particular when setting $\mu = g$ we see that the optimal linear rate is positive if $\int_i (g_i - g)\frac{x_i}{x} di < 0$, negative otherwise. $\int_i (g_i - g)\frac{x_i}{x} di$ is negative if the good is consumed more by richer households (for which $g_i - g < 0$) than by the average household, so negative if the good is a normal good, positive if the good is an inferior good.

Proposition (1) is not affected by assumptions on the social welfare weights. Proposition (2) can now be written as:

$$\begin{aligned} dW^R(q) = &-(\mu - g)\frac{\phi(q)}{\theta(q)-1} + \int_i (g_i - g)\frac{x_i}{x} di (\frac{\phi(q)}{\theta(q)-1} + 1) \\ &- \int_{x_i \geq q} (g_i - g)\frac{(x_i - q)}{(x_2(q) - q)(1 - H(q))} di \end{aligned} \tag{A15}$$

The key conclusions detailed in the paper are unchanged. The behavioral parameter $\phi(q)$ has a negative impact on the welfare effect of the RSS if the optimal linear rate t^* defined in expression (A14) is positive, negative otherwise. The welfare effect of introducing a RSS is increasing in $\int_i (g_i - g)\frac{x_i}{x} di$, an expression equivalent to the share of poor consumption α in the paper, and decreasing in $\int_{x_i \geq q}(g_i - g)\frac{(x_i-q)}{(x_2(q)-q)(1-H(q))}di$, the equivalent to $\alpha_2(q)\pi_2(q)$.

Results with home production

I introduce the possibility that households consume from their own production of the good by assuming that each household is endowed with an amount of the good ω_i.[1] This endowment can be consumed or sold on the market at price z so its value to the household ($z\omega$) is increasing in market prices. Household i's budget constraint under a linear tax is thus $(z+t)x_{im} + zx_{ih} \leq R_i + z\omega_i$ where R is non-endowment income and x_m is purchased amounts of the good, $x_h \leq \omega$ consumption from home production. Redefining $x = x_m$ and $y(z) = R + z\omega$ the welfare effect of introducing a RSS in the absence of price risk is still given by expression (3).

In a world with price risk home production endowments play a more significant role: they provide households with partial insurance against changes in market prices as endowment income increases with the price. We have:

$$\frac{dv_y(y_i(z), z)}{dz} = v_{yyi}\omega_i + v_{yzi}$$

Taking the derivative of Roy's identity with respect to income and rearranging yields the following expression for the impact of prices on the marginal utility of income v_{yi}:

$$\frac{dv_{yi}(y_i(z), z)}{dz} = \frac{v_{yi}(y_i(z), z)}{z+t}[s_i(z)(r-\eta) - rs_{\omega i}(z)], \tag{A16}$$

where s_{wi} is the endowment income share. Households with a large endowment relative to their consumption of the good (and in particular net producers of the good for which $s_{\omega i} > s_i$) will see their marginal utility of income decrease with z: for these households the positive effect of an increase in price on their endowment income outweighs the negative impact on the consumption price.

The total insurance effect of introducing a ration shop system in a world with price risk and home production endowments is therefore equal to the insurance effect in a world without endowments plus an extra term that's a weighted function of households' endowment shares:

[1] The assumption of fixed endowments is motivated by data constraints in the calibration exercise. I discuss its implications (no efficiency cost of providing insurance) below.

$$dW^H(q) = dW^P(q) + \sigma^2\{+\epsilon r \left[\frac{\int_{x_i \geq q} g_i s_{\omega i} x_i}{x_2(q)(1-H(q))}\frac{\theta(q)}{\theta(q)-1} + \frac{\int g_i s_{i\omega} x_i}{x}(1+\frac{\phi(q)}{\theta(q)-1})\right] \tag{A17}$$

$$- r(\bar{z}+t)\left[\frac{\int_{x_i<q} g_i s_{\omega i} x_i}{x_1(q)H(q)}\frac{\theta(q)}{\theta(q)-1} + \frac{\int_{x_i \geq q} g_i s_{\omega i} q}{(x_2(q)-q)(1-H(q))}\right]$$

$$+ \epsilon(\bar{z}+t)\frac{\int_{x_i<q}(\mu - g_i) s_{\omega i} x_i}{x_1(q)H(q)}\frac{\gamma(q)}{\theta(q)-1}\}.$$

Proof: In the presence of endowments that can be sold at price z Roy's identity entails $\frac{\partial v_i}{\partial t} = v_{yi} x_{im}$ where x_{im} is total purchases of the good. We also have $\frac{\partial x_i}{\partial t} = \frac{\partial x_{im}}{\partial t} + \frac{\partial x_{ih}}{\partial t}$ where x_i is total consumption and x_{ih} consumption from home production. Consumption from home production is a function of the sign of t: if $t > 0$ households consume all their endowment ($c_h = q$) whereas if $t < 0$ households sell all their endowment ($c_h = 0$). In both cases the assumption of a fixed endowment implies that $\frac{\partial x_h}{\partial t} = 0$ and $\frac{\partial x_i}{\partial t} = \frac{\partial x_m}{\partial t}$. Overall we can write the total welfare effect in a world without price risk but with home production endowment as expression (3) in the paper (redistribution effect) where θ, α, α_2 and π_2 are defined with respect to purchased amounts x_{im}.

The extra terms that are a function of the distribution of $s_{\omega i}$ will be negative for most values of the parameters for the same reasons that (5) tends to be positive. Intuitively the endowments provide households with some insurance against price risk by indexing part of their income to the price and therefore lower the potential insurance gains from introducing a RSS. The total insurance effect will therefore be lower for goods for which i) endowments represent a higher share of income on average ii) households with high purchases of the good (those for which the potential insurance effect is highest) also have high endowments iii) endowments represent a larger share of poor households' incomes.

Limited targeting capacity

Here I consider a situation in which the government has a pro-poor transfer which reaches the poor with probability $\hat{\pi}$ and therefore sets a value $\hat{\pi} g_p + (1-\hat{\pi}) g_{np}$ to marginal public funds.

Expression (3) in the paper (redistribution effect) is now given by

$$dW(q) = -(g_p - g_{np})(\hat{\pi} - \pi)\frac{\phi(q)}{\theta(q)-1} + (g_p - g_{np})[\pi\alpha - \pi_2(q)\alpha_2(q) - \pi_2(q)\frac{\alpha_2(q)-1}{\theta(q)-1} - (1-\alpha)\frac{\phi(q)}{\theta(q)-1}\pi] \quad \text{(A18)}$$

where $\hat{\pi} > \pi$ as long as the government has some targeting capacity. Similarly the extra insurance term in expression (5) (insurance effect) becomes:

$$\sigma^2\{-\epsilon(r-\eta)(\frac{\int_{x_i \geq q} g_i s_i x_i}{x_2(q)(1-H(q))}\frac{\theta(q)}{\theta(q)-1} - \frac{\int g_i s_i x_i}{x}(1+\frac{\phi(q)}{\theta(q)-1})) + (r-\eta)(\bar{z}+t)(\frac{\int_{x_i<q} g_i s_i x_i}{x_1(q)H(q)}\frac{\theta}{\theta-1} + \frac{\int_{x_i \geq q} g_i s_i q}{(x_2(q)-q)(1-H(q))}) - \epsilon(\bar{z}+t)\frac{\int_1 (g + (g_p - g_{np})(\hat{\pi}-\pi) - g_i)s_i x_i}{x_1(q)H(q)}\frac{\gamma(q)}{\theta(q)-1}\}$$

Comparing the above expressions to a situation with no targeting capacity and $\mu = g$ we see that the welfare effect is comprised of an added term $(g_p - g_{np})(\hat{\pi} - \pi)[-\frac{\phi(q)}{\theta(q)-1} - \sigma^2\epsilon(\bar{z}+t)\frac{\gamma(q)}{\theta(q)-1}]$. Given the low values of ϵ and σ^2 observed this added term will in practice always be negative and increasing in absolute value with the government's targeting capacity $\hat{\pi} - \pi$.

Corruption

Consider a world in which for every INR transferred to households through the RSS $(1+\beta)$ INR must be spent by the government. In this case the welfare impact of the RSS can be rewritten as:

$$dW(q) = \int_{x_i<q} g_i x_i + \int_{x_i \geq q} g_i q - \mu(1+\beta)(x_1 H(q) + q(1-H(q))) + \mu\frac{t}{z+t}(\epsilon_1 x_1 H(q) + \eta_2 s_2 q(1-H(q))) \quad \text{(A19)}$$

Re-arranging we obtain:

$$
\begin{aligned}
dW(q) =& -(\mu-g)\frac{\phi(q)}{\theta(q)-1} + (g_p - g_{np})[\pi\alpha - \pi_2(q)\alpha_2(q) - \pi_2(q)\frac{\alpha_2(q)-1}{\theta(q)-1} \\
& -(1-\alpha)\frac{\phi(q)}{\theta(q)-1}\pi] - \mu\beta\frac{\gamma(q)+1}{\theta(q)-1}
\end{aligned}
$$

where the last term $-\mu\beta\frac{\gamma(q)+1}{\theta(q)-1} < 0$ captures the loss in welfare because of the leakage.

Taxation of several goods

The analysis of the welfare effect of introducing a RSS on good k changes in two ways when we allow for all other goods j to be taxed. First, it changes the value of the optimal linear income tax on good k. To see this start by defining the cross-price elasticity of demand:

$$
\epsilon_i^{jk} = \frac{\partial x_i^j}{\partial z^k}\frac{z^k+t^k}{x_i^j}
$$

The optimal linear tax rate is then given by:

$$
\frac{t^k}{z^k+t^k} = \frac{(\mu-g)+(g_p-g_{np})\pi(1-\alpha)+\sum_{j\neq k}\frac{t^j}{z^k+t^k}\epsilon^{kj}\frac{x^j}{x^k}}{-\mu\epsilon}
$$

The last term captures the effect of increasing the tax on good k on demand for all other taxed goods j. Its sign depends on the sign of the linear rates t^j and whether goods j and k are substitutes or complements. For example if most goods j are substitutes for k ($\epsilon_i^{jk} > 0$) the last term is positive and the optimal linear tax rate increases because of cross-price effects.

The revenue impact of introducing a ration shop system is now given by

$$
\begin{aligned}
dR =& (1-H(q))\{x_2^k - q^k - \frac{t^k}{z^k+t^k}(x_2^k\epsilon_2^k - \eta_2^k s_2^k q^k) \\
& -\sum_{j\neq k}\frac{t^j}{z^k+t^k}(x_2^j\epsilon_2^{jk} - \eta_2^j s_2^j q^k\frac{z^k+t^k}{z^j+t^j})\}
\end{aligned} \tag{A20}
$$

where the subscript 2 indicates that the variable is the average over all households with $x_i^k \geq q^k$. The last term captures the impact of increasing the tax on k above a quota q^k on demand for all other taxed goods. This is a function of the cross-price elasticity of demand of these goods and their income effects, the sign of the term depends again on the sign of t^j, η^j and ϵ^{jk}.

All other aspects of the impact of introducing a ration shop system remain the same: introducing a tax on other goods only affects the behavioral effect. To calibrate this effect we would need to know the cross price elasticity of demand for the goods considered. Estimates of cross-price elasticities of demand for food and fuel do not exist for India and are hardly ever available for developing countries[2]. Cross-price elasticities across goods considered are likely small compared to own-price elasticities and income effects are negligible for most goods (see Table 3), so the extra behavioral effects that arises because of cross-price effects is of second order compared to the main behavioral effect. The three cereal types are probable substitutes but taste persistence (documented for India in Atkin (2013)) and geographical differences in the availability of these three cereal types may lead to small cross-good substitution effects even for these goods.

Several varying prices

Let's define $\mathbf{z}$ the vector of prices of goods j, where each price is now allowed to vary. As before we consider the price-invariant transfers equivalent to taxes and transfers indexed to the price of one good k. The impact of a tax dt^k on consumption of good k is:

$$\begin{aligned} E(v_i(y_i, \mathbf{z}, dt^k) =& E(v_i(y_i, \mathbf{z})) - v_{iy} x_i^k (1 - \epsilon_i^k s_i^k (r_i - \eta_i^k) \sigma_z^{k2}) dt^k \\ & - v_{iy} \sum_{j \neq k} \epsilon_i^k s_i^j (r_i - \eta_i^j) \sigma_z^{k2} \sigma_z^{j2} \rho_{jk} (\bar{z}^k + t^k)(\bar{z}^j + t^j) \end{aligned}$$

where ρ_{jk} is the correlation coefficient between the prices of goods j and k. The insurance effect of a consumption tax on good k is increasing in the covariance between the price of good k and that of all other goods.

The impact of receiving a transfer $(z^k - \bar{z}^k)q^k$ on utility is now:

[2]One exception is Deaton (1987) for Cote d'Ivoire who considers four types of food commodities.

$$E(v_i(y_i + (z^k - \bar{z}^k)q^k, \mathbf{z} + \mathbf{t}) = E(v_i(y_i, \mathbf{z} + \mathbf{t})) + v_{yi}q^k s_i^k (r_i - \eta_i^k)(\bar{z}^k + t^k)(\bar{z}^j + t^j)\sigma_z^{k2} + v_{yi}q^k s_i^k \sum_{j \neq k}(r_i - \eta_i^j)\sigma_z^{k2}\sigma_z^{j2}\rho_{jk}$$

Allowing for the prices of other goods to vary therefore increases the insurance effect of a transfer indexed to the price of good k if the prices of goods are positively correlated and decreases it otherwise.

The insurance effect of stabilizing the price of good k to its mean $\bar{z}^k$ can similarly be written as:

$$E(v_i(y_i, \mathbf{z} + \mathbf{t}, \bar{z}^k + t^k) = E(v_i(y_i, \mathbf{z} + \mathbf{t})) + v_{iy}(s_i^k(r_i - \eta_i^k) - \epsilon_i^k)x_i(\bar{z} + t)\sigma^2 + \sum_{j \neq k} v_{iy}(s_i^j(r_i - \eta_i^j)\sigma_z^{k2}\sigma_z^{j2}\rho_{jk}$$

where I assume $E[(z^j - \bar{z}^j)(z^k - \bar{z}^k)^2] \approx 0$.

A2 Context section

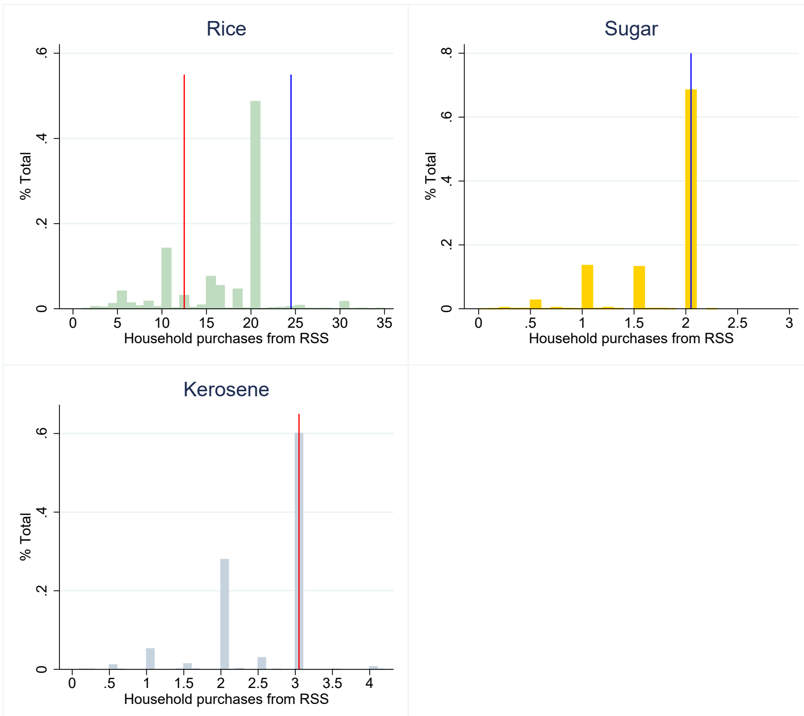
A2.1 Consumption from RSS and RSS quotas

Figure A1 presents the distribution of household purchases in ration shops in Tamil Nadu for the three main goods sold in that state. I present results for Tamil Nadu both because in that state quota amounts vary little across households and because most households report being able to access their official quota amount - see Khera and Dreze (2011). This makes it possible to assess whether households are choosing to buy less than their allocated quota. In other states official quota amounts vary by household characteristics not observed in the data.

Official quotas for rice and sugar are defined at the individual level in Tamil Nadu (see below) but the state also specifies minimum and maximum quota amounts at the household level. These are for rice a minimum of 12 kilos and a maximum of 24, for sugar a maximum of 2 kilos (no minimum specified). For kerosene the quota amount varies by location but is 3 litres for the vast majority of households. To obtain the share of households for which the quota is strictly marginal (households consuming less than their allocated quota) I compute each households' allocated quota based on their household size and apply the minimum and maximum quota rules for sugar and rice. For kerosene I assume the allocated quota is 3 litres for all households. I find that the quota is marginal for 23% of households for rice, 11% for sugar and 33% for kerosene.

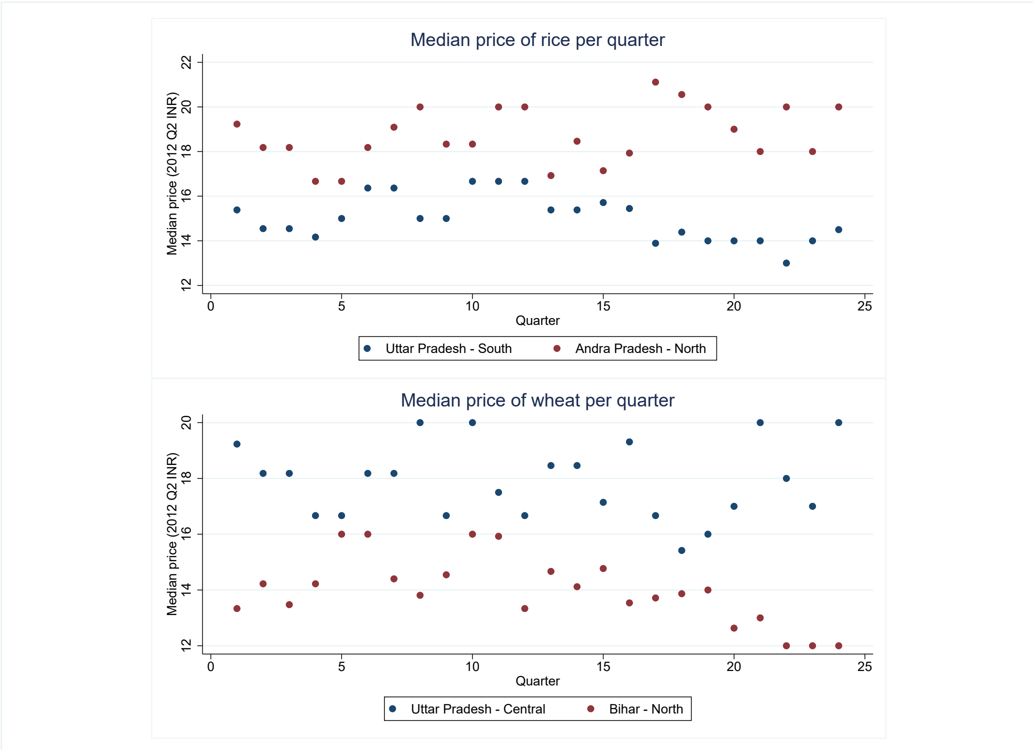
Figure A2 plots variation in commodity prices within market over time by plotted median market prices in each quarter in the two largest regions in India over the period 2004-2012. Prices are deflated using the per commodity all-India average means, regions are the smallest geographic area for which the data is representative in all periods.

Figure A1: Household purchases from ration shops, Tamil Nadu



These graphs present the density distribution of consumption from ration shops for the three main goods found in the RSS in the state of Tamil Nadu. The vertical blue line indicates the maximum quota at the household level, the vertical red line indicates the minimum quota at the household level. Consumption is at the household level and per month, reported by households in the NSSO consumption survey. See the text for a description of the data used.

Figure A2: Price variation within large regions over time



Each point represents a mean real market price. Unit values are used as a proxy for prices which are in INR per kilo and deflated using the mean all-India value of the price of the good in each quarter, with the last quarter used as the reference. The period starts in the third quarter of 2004 and ends with the second quarter of 2012. For each good (rice in the top graph, wheat in the bottom graph) I consider the two NSS sub-regions (the most granular geographical level at which the data is representative in all periods) with the highest number of households consuming the good from the market. All values are reported by households in the NSSO consumption surveys for the years 2002-2003 to 2011-2012.

A2.2 State-level ration shop systems

Comparing official quotas and ration prices to reported consumption and prices from ration shops

I detail below the ration shop systems implemented by major Indian states in 2011: types of goods distributed, eligibility to use ration shops, ration quotas and prices. The initials APL and BPL correspond to households categorized as 'Above-Poverty-Line' or 'Below-Poverty-Line' by the state government and 'AAY' (Antyodaya Anna Yoyana) correspond to households categorized as 'poorest of the poor'. Applying official poverty lines at the state level 22% of households belong to the BPL category, of these roughly 1/4th are considered AAY. Quotas are kilos or litres per household per month and prices INR per kilos or litres, unless otherwise specified. The main source used is Balani (2013) which accessed state websites in 2011, I complement with Khera (2011), Khera and Dreze (2011) and state level reports when needed.

Uttar Pradesh
Goods: rice, wheat, sugar, kerosene.
Eligibility: all households, different entitlements for each household type.
Quotas: Rice 20 AAY, 12 APL and BPL; Wheat 13 APL and BPL, 20 AAY; Sugar 0.7 AAY and BPL, 0 APL; Kerosene: 3 all.
Official prices: Rice 3 AAY, 6.15 BPL, and 8.45 APL; Wheat 2 AAY, 4.6 BPL and 6.6 APL; Sugar 13.5 AAY and BPL; Kerosene: 16 all.

Bihar
Goods: rice, wheat, sugar, kerosene.
Eligibility: all for foodgrains, different entitlements for each household type, BPL and AAY only for sugar and kerosene.
Quotas: Rice 21 AAY, 15 BPL and 11 APL; Wheat 14 AAY, 10 BPL, 7 APL; Sugar 1 AAY and BPL; Kerosene: 5 AAY and BPL.
Prices: Rice 3 AAY, 7 BPL, and 9 APL; Wheat 2 AAY, 5 BPL and 7 APL; Sugar 13 all; Kerosene: 17 all.

Madhya Pradesh
Goods: rice or wheat (in practice mostly wheat), sugar, kerosene.
Eligibility: all households, different entitlements for each household type.
Quotas: Rice or Wheat 35 AAY, 20 BPL and 5 APL; Sugar 1.8 AAY and

BPL, 0 APL; Kerosene: 5 AAY and BPL, 2-4 APL.
Prices: Rice 4 for all; Wheat 3 for all; Sugar 14 all; Kerosene: 15 for all.

Tamil Nadu
Goods: rice, wheat (fortified atta), sugar, kerosene.
Eligibility: all households.
Quotas: Rice 4/adult and 2/child; Wheat 5/household; Sugar 0.5/adult; Kerosene: 3-15.
Prices: Rice 0; Wheat 7.50; Sugar 13.5; Kerosene: 13.6-14.2.

Rajasthan
Goods: rice or wheat (in practice mostly wheat), sugar, kerosene.
Eligibility: all for foodgrains, different entitlements for each household type, BPL and AAY only for sugar and kerosene.
Quotas: Rice or wheat 35 AAY, 25 BPL, 25 APL; Sugar 0.5/adult AAY and BPL; Kerosene: 2-5 AAY and BPL.
Prices: Rice 3 AAY, 6 BPL, 7 APL; Wheat 2 AAY and BPL, 7 APL; Sugar 13; Kerosene: 14.

Kerala
Goods: rice and wheat, sugar.
Eligibility: all, (very) different entitlements and price for each household type.
Quotas: Rice 35 AAY 25 BPL 10 APL; Wheat 5 AAY or BPL, 3 APL; Sugar 1.5 AAY and BPL 0 APL; Kerosene: 1.5 AAY and BPL.
Prices: Rice 1 AAY and BPL, 9 APL; Wheat 2 AAY and BPL, 7 APL; Sugar 13; Kerosene: 15.

Table A1 reports average consumption from the ration shops and average ration prices among households consuming the good from ration shops in each state, using values reported by households in the NSSO consumption survey. Declared consumption and prices cannot be directly compared to official quotas and prices as the survey does not contain information on households' state-allocated poverty status. Moreover households could choose to consume less than their total quota every month, evidence above suggests a non-negligible share of households indeed do so. Note that in Rajasthan and Madhya Pradesh very few households consume rice from the RSS (less than 1%) and in Bihar very few households consume sugar (less than 8%), so I choose not to report values for these goods and states. The ration price for rice in Tamil Nadu is missing by construction: when a good is purchased at a zero price NSSO surveyors use the market price of the good to estimate the value of the purchase so unit values contain no information on ration prices for that state. Overall we see that households consume on average amounts that are close to (but typically at the lower end of) the range of quotas for APL and BPL households. Ration prices as reported by households are similarly within the range of official prices, though slightly higher in Bihar.

Table A1: Consumption from ration shops and ration prices by state

	Bihar	Kerala	Madhya Pradesh	Rajasthan	Tamil Nadu	Uttar Pradesh
Consumption from ration shops						
Rice	15.07	19.55	.	.	18.88	19.99
	(1.359)	(8.507)	.	.	(7.733)	(7.916)
Wheat	12.48	3.265	19.92	24.85	2.605	15.04
	(4.421)	(1.885)	(8.340)	(0.948)	(1.561)	(4.936)
Sugar	.	1.602	1.851	2.807	1.837	2.107
	.	(0.731)	(0.600)	(0.441)	(0.550)	(0.801)
Kerosene	2.438	1.315	3.298	1.715	2.958	2.679
	(0.148)	(0.752)	(1.404)	(1.292)	(1.442)	(0.853)
Ration prices						
Rice	10.05	2.138	.	.	.	5.233
	(7.697)	(2.346)	.	.	.	(1.789)
Wheat	7.974	5.469	3.054	3.855	8.495	4.004
	(5.199)	(4.819)	(0.881)	(1.226)	(1.596)	(1.606)
Sugar	.	14.62	14.48	13.80	13.65	15.26
	.	(3.408)	(2.225)	(0.717)	(0.732)	(1.673)
Kerosene	18.93	14.55	15.43	13.60	13.60	15.96
	(2.017)	(2.354)	(1.418)	(0.912)	(1.367)	(1.204)

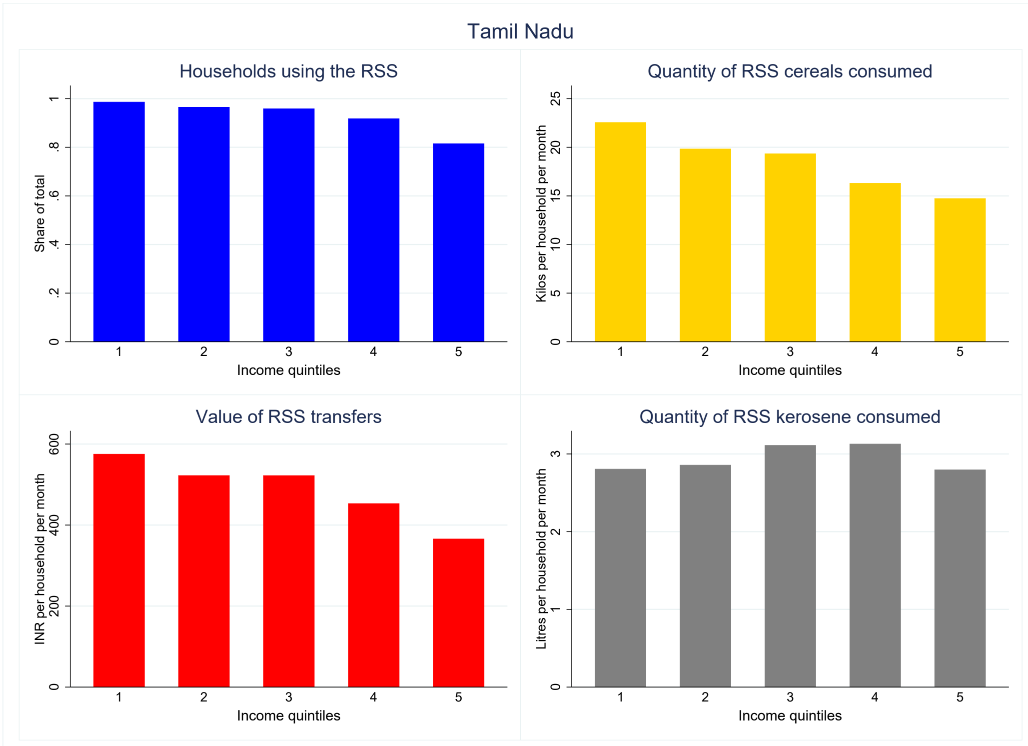
Mean (standard deviation). Consumption is per household per month, for each good means are taken over households that consume positive amounts of the good from ration shops. Consumption and prices are reported by households in the NSSO survey 2011-2012. See the text for the description of the data used.

Targeting by design vs targeting in practice

Looking at official entitlements and prices by household type we can roughly categorize these 6 states in 3 categories based on how different their ration entitlements are for poor and non-poor households: Tamil Nadu has a universal RSS and does not attempt to target entitlements, Kerala and Madhya Pradesh are the most 'targeting' states - entitlements for APL households are less than half those for other households (though note that in Madhya Pradesh ration prices are the same for all), and Uttar Pradesh, Bihar and Rajasthan fall in between these two polar cases. Khera and Dreze (2011) labels both Rajasthan and Bihar as states that have 'universalized' their RSS in the 2000s by expanding their definition of what is a 'BPL' household. Figures A3 to A8 considers to what extent the RSS achieves targeting of poor households in practice in each state, using consumption from the RSS as reported by households in 2011-2012. The first (top left) graph presents targeting at the extensive margin: the share of households that report using the RSS in 2011-2012 in each expenditure quintile. Note that the official share of poor households (using official state level poverty lines) in India is 22%, so on average only households in the first quintile should be considered as poor. The remaining graphs consider targeting at the intensive margin: I plot the value of the RSS transfer (bottom left graph) and the total quantity of cereals or kerosene purchased through the RSS (right hand side graphs) among households that use the RSS.

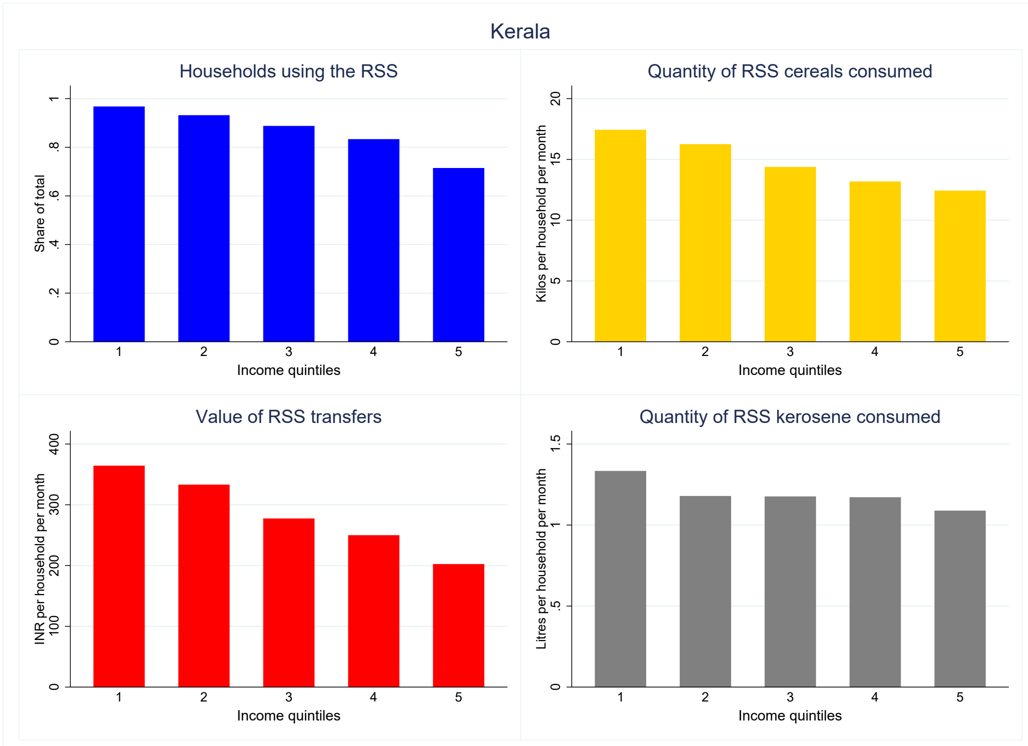
The graphs suggest that states that attempt to target RSS transfers mostly to poor households do not achieve a much more progressive distribution of transfers than those that don't. Looking at the extensive margin we see that Madhya Pradesh does achieve better targeting than most other states (though not Rajasthan), with households in the richest quintile being half as likely to use the RSS as households in the highest quintile, but Kerala does not - richest households are only 25% less likely to use the RSS than poorest households, a situation very similar to that in Tamil Nadu where all households have the same rights. Rajasthan stands out as the state with the highest income gradient at the extensive margin, but Bihar (whose official RSS rules are if anything slightly more targeted than those in Rajasthan) has the worse targeting outcome, with the poorest quintile being less likely to use the RSS than the second, third and fourth quintiles. On the intensive margin we see that households in the richest quintile never get less than 30% of the transfer received by the poorest quintile. Targeting is worse in Tamil Nadu, Bihar and Kerala, whilst both Madhya Pradesh and Uttar Pradesh achieve the best targeting on the intensive margin. Looking at different goods separately we see that consumption of cereals through the RSS is more targeted than consumption of kerosene in all states except Bihar.

Figure A3: Targeting of RSS, Tamil Nadu



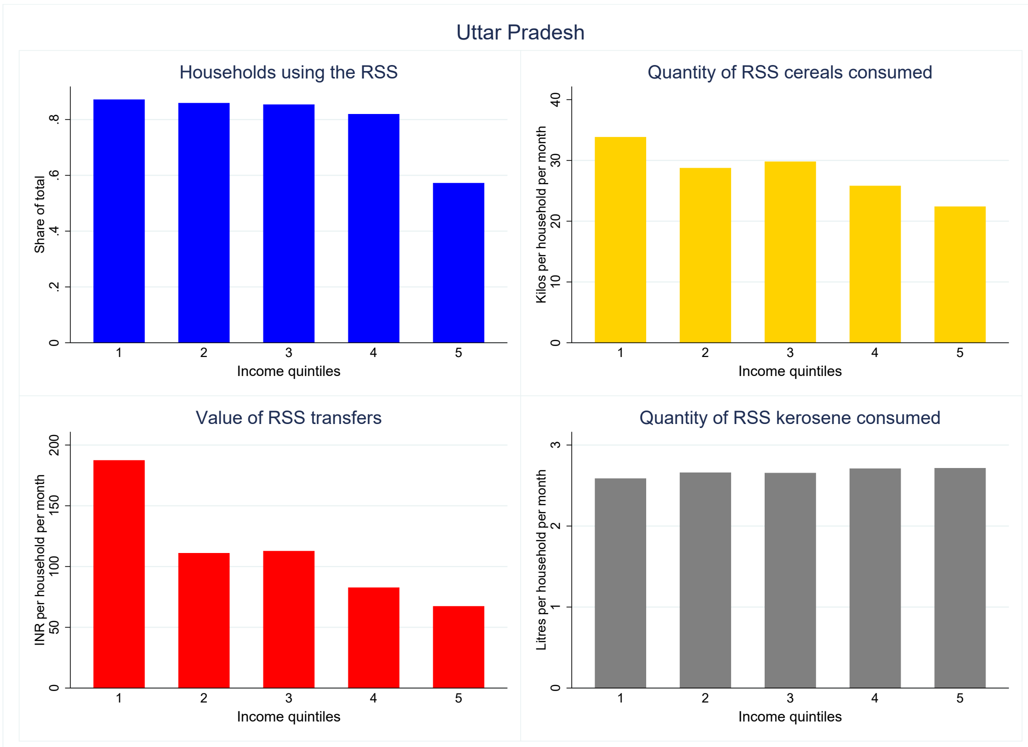
Each graph plots the distribution of a variable by quintile of total expenditure per capita. The top left graph plots the share of households that use the RSS, the bottom left graph the value of RSS transfers (conditional on using the RSS), the top and bottom right graph the quantity of RSS cereals (rice or wheat) or kerosene consumed (conditional on using the RSS). Use of ration shops, consumption of goods and expenditure per capita are reported by households in the NSSO consumption survey, see the text for a description of the data used.

Figure A4: Targeting of RSS, Kerala



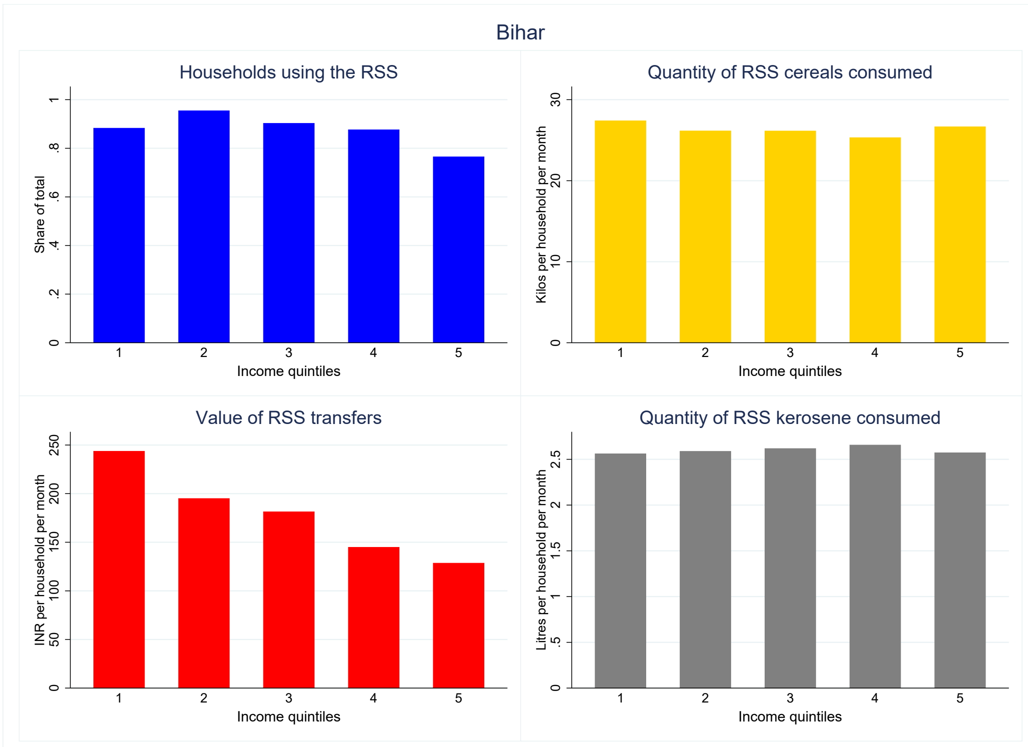
Each graph plots the distribution of a variable by quintile of total expenditure per capita. The top left graph plots the share of households that use the RSS, the bottom left graph the value of RSS transfers (conditional on using the RSS), the top and bottom right graph the quantity of RSS cereals (rice or wheat) or kerosene consumed (conditional on using the RSS). Use of ration shops, consumption of goods and expenditure per capita are reported by households in the NSSO consumption survey, see the text for a description of the data used.

Figure A5: Targeting of RSS, Uttar Pradesh



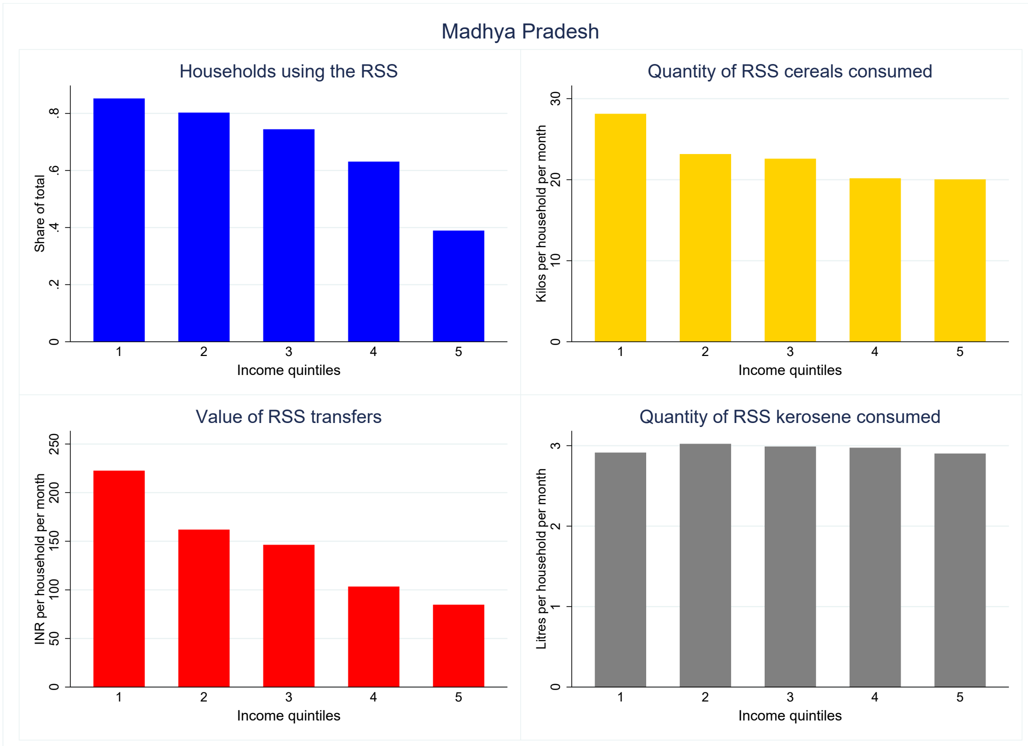
Each graph plots the distribution of a variable by quintile of total expenditure per capita. The top left graph plots the share of households that use the RSS, the bottom left graph the value of RSS transfers (conditional on using the RSS), the top and bottom right graph the quantity of RSS cereals (rice or wheat) or kerosene consumed (conditional on using the RSS). Use of ration shops, consumption of goods and expenditure per capita are reported by households in the NSSO consumption survey, see the text for a description of the data used.

Figure A6: Targeting of RSS, Bihar



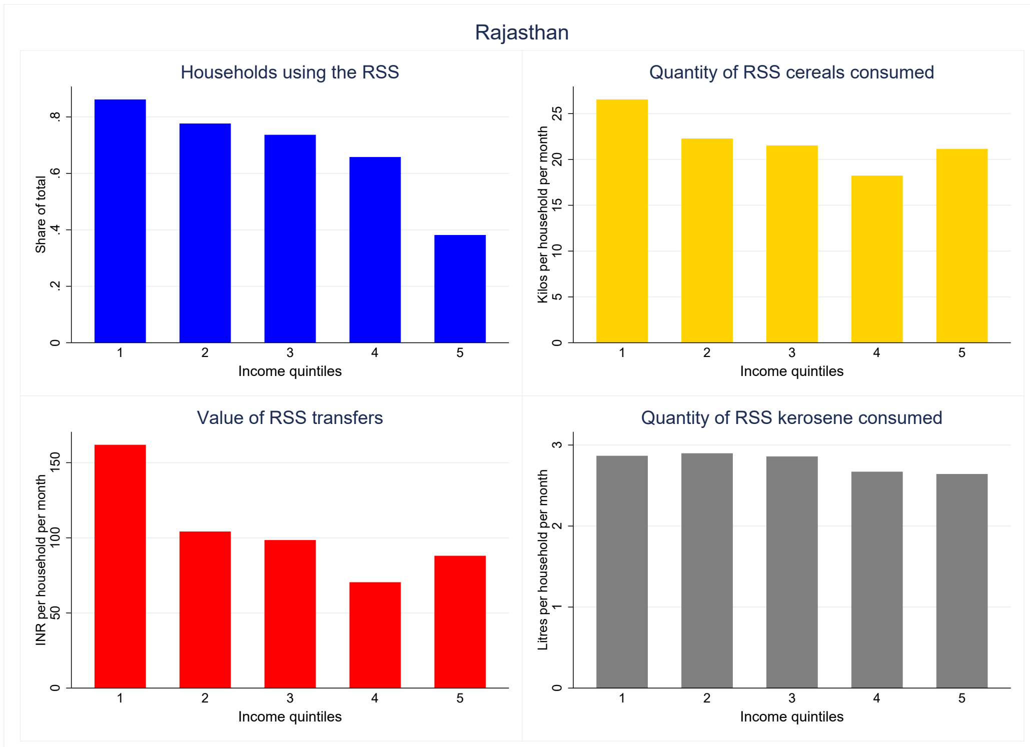
Each graph plots the distribution of a variable by quintile of total expenditure per capita. The top left graph plots the share of households that use the RSS, the bottom left graph the value of RSS transfers (conditional on using the RSS), the top and bottom right graph the quantity of RSS cereals (rice or wheat) or kerosene consumed (conditional on using the RSS). Use of ration shops, consumption of goods and expenditure per capita are reported by households in the NSSO consumption survey, see the text for a description of the data used.

Figure A7: Targeting of RSS, Madhya Pradesh



Each graph plots the distribution of a variable by quintile of total expenditure per capita. The top left graph plots the share of households that use the RSS, the bottom left graph the value of RSS transfers (conditional on using the RSS), the top and bottom right graph the quantity of RSS cereals (rice or wheat) or kerosene consumed (conditional on using the RSS). Use of ration shops, consumption of goods and expenditure per capita are reported by households in the NSSO consumption survey, see the text for a description of the data used.

Figure A8: Targeting of RSS, Rajasthan



Each graph plots the distribution of a variable by quintile of total expenditure per capita. The top left graph plots the share of households that use the RSS, the bottom left graph the value of RSS transfers (conditional on using the RSS), the top and bottom right graph the quantity of RSS cereals (rice or wheat) or kerosene consumed (conditional on using the RSS). Use of ration shops, consumption of goods and expenditure per capita are reported by households in the NSSO consumption survey, see the text for a description of the data used.

A3 Model section

Table A2 presents market level pair-wise correlation coefficients over time (across quarters) for the goods considered in the calibration. A market is defined as a NSSO sub-region and prices are deflated using a commodity specific deflator, I use the annual rounds of the NSSO consumption surveys 2001-2002 to 2011-2012. To avoid capturing variations that are due to changes in the item-level composition of consumption in each good category of interest I consider the price variation of the most widely consumed item in each good category for each sub-region. I take the mean market price in each sub-region and quarter and compute the within sub-region correlation in these mean prices across goods in each sub-region.

Table A2: Region level correlations in commodity prices

	Rice	Wheat	Kerosene	Sugar	Coarse cereals	Pulses	Meat and fish products
Rice	1	0.22 (0.26)	0.03 (0.13)	0.06 (0.21)	0.09 (0.25)	0.00 (0.29)	0.10 (0.26)
Wheat	0.22 (0.26)	1	0.11 (0.25)	0.08 (0.25)	0.20 (0.37)	0.12 (0.34)	0.01(0.28)
Kerosene	0.03 (0.13)	0.11 (0.25)	1	0.06 (0.21)	0.05 (0.25)	0.09 (0.30)	0.02 (0.25)
Sugar	0.06 (0.21)	0.08 (0.25)	0.06 (0.21)	1	0.04 (0.32)	0.12 (0.25)	0.07 (0.27)
Coarse cereals	0.09 (0.25)	0.20 (0.37)	0.05 (0.25)	0.04 (0.32))	1	0.06 (0.31)	0.06 (0.25)
Pulses	0.00 (0.29)	0.12 (0.34)	0.09 (0.30)	0.12 (0.25)	0.06 (0.31)	1	-0.01 (0.30)
Meat and fish products	0.10 (0.26)	0.01(0.28)	0.02 (0.25)	0.07 (0.27)	0.06 (0.25)	-0.01 (0.30)	1

Each cell is the mean (standard deviation) of the within NSS sub-region correlation coefficients between the price of the column commodity and the price of the row commodity. The price of the item most commonly consumed in the region is used in each region. The data used are the annual NSS consumption surveys 2002 to 2012, see the text for a description of the data.

A4 Data and method section

A4.1 Commodities included in each good category

Each good category considered in the calibration is composed of the following item commodities in the NSSO consumption survey:
Rice: rice, chira (flattened rice), khoi (popped rice), muri (flattened rice). Wheat: wheat, maida (wheat flour), suji (wheat flour). Kerosene: kerosene. Sugar: sugar.
Coarse cereals: jowar, bajra, maize, barley, millets, ragi.
Pulses: arhar, gram, moong, masur, khesari, besan, peas, soyabean, other pulses.
Meat & fish products: fish, mutton, beef, pork, chicken, eggs, other meat & fish.
Cooking gas: Liquid Petroleum Gas.

A4.2 Home production

At baseline I simply assume that a household's consumption from home production is equal to its endowment. This likely under-estimates households' endowments: households that produce goods available in ration shops may choose to sell their endowments because the market price is higher than the ration price. I therefore also estimate alternative endowment values using the fact that land is the main input into home production and information in the survey about the amount of land owned by each household. To do this I assume that households that do not use the ration shop system have an incentive to consume their home production and estimate the relationship between land and consumption of each good from home production amongst these households.This assumption would be problematic if rural households had worse access to the RSS, as was the case in the 1990s, because rural households are more likely to have land and consume from home production. However as shown in Appendix Figure A13 and in the literature (see for example Himanshu, 2013a) in the period considered rural households have if anything better access to ration shops than urban households, with 83% of rural households using them. Crops are differently suited to different areas so I estimate the relationship separately in each NSS sub-regions. I then use these estimates to predict each household's endowment of each good based on the amount of land they own.

A4.3 Price risk

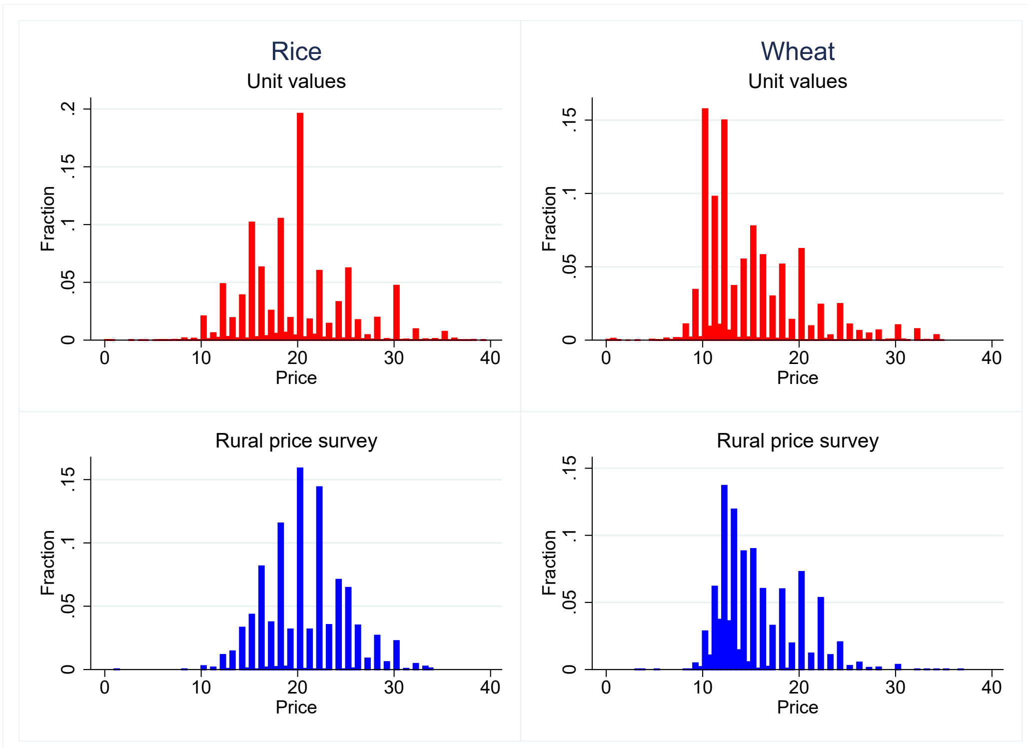
There are several known shortcomings of using unit values as a proxy for prices as I do in the paper: variations in unit values may reflect measurement error, quality effects, or nonlinear price schedules (as discussed in Deaton and Tarozzi, 2005). These concerns imply that I could be over-estimating the level of price risk faced by households. To assess the seriousness of these concerns for unit values obtained using the NSSO consumption survey I compare the distribution of these unit values to the price measures obtained by the NSSO in its Rural Price Collection (RPC) survey (NSSO, 2013). The RPC survey collects data on rural retail prices of 260 commodities from market and shops every month from a fixed set of 603 villages, the data is then used to compile the rural consumer price index. In graphs A9 to A12 I plot the distributions of unit values from the consumption survey (top panels) and prices from the RPC survey (bottom panels). I restrict the NSSO consumption survey to rural areas, only consider states which are found in both datasets and exclude Delhi for which very few rural observations are available. The RPC survey has several item categories for rice and wheat, I use the category most commonly reported for both goods ('Rice (medium)' and 'Wheat (medium)'). Jowar and arhar are the most commonly consumed items in the 'coarse cereals' and 'pulses' good categories in the paper, both are also item categories in the RPC survey. Sugar and kerosene are item categories in both the RPC and the NSSO consumption survey. I plot the distribution for the two most widely consumed types of meat (chicken - labelled poultry in the RPC survey - and mutton). The RPC survey does not collect price information for cooking gas.

Coefficients of variation in 2011 for unit values across the states considered are: 0.29 (rice), 0.38 (wheat), 0.37 (jowar), 0.18 (arhar), 0.08 (sugar), 0.27 (kerosene), 0.22 (chicken) and 0.19 (mutton). Coefficients of variations in 2011 for prices in the RPC survey across the states considered are extremely similar: 0.23 (rice), 0.37 (wheat), 0.47 (jowar), 0.12 (arhar), 0.09 (sugar), 0.59 (kerosene), 0.31 (chicken) and 0.17 (mutton).

To proxy for the price risk that a typical Indian household faces I consider within-market variations in unit values over time using the annual NSSO household surveys for the years 2002-2003 to 2011-2012. I define a market as the lowest geographical unit at which the surveys are representative in all years - the rural and urban parts of each of the 77 NSS regions (hereafter sub-regions).Sub-regions are areas within a state with similar agro-climatic conditions. Evidence in Atkin (2013) suggests each village in rural India may be a separate market, but village-level price data is not available. The higher level of aggregation used here likely under-estimates the level of price risk faced by households if shocks are not highly correlated across villages within a region. The 2008-2009 and 2010-2011 surveys did not include an expenditure module so I do not observe prices for these two periods.

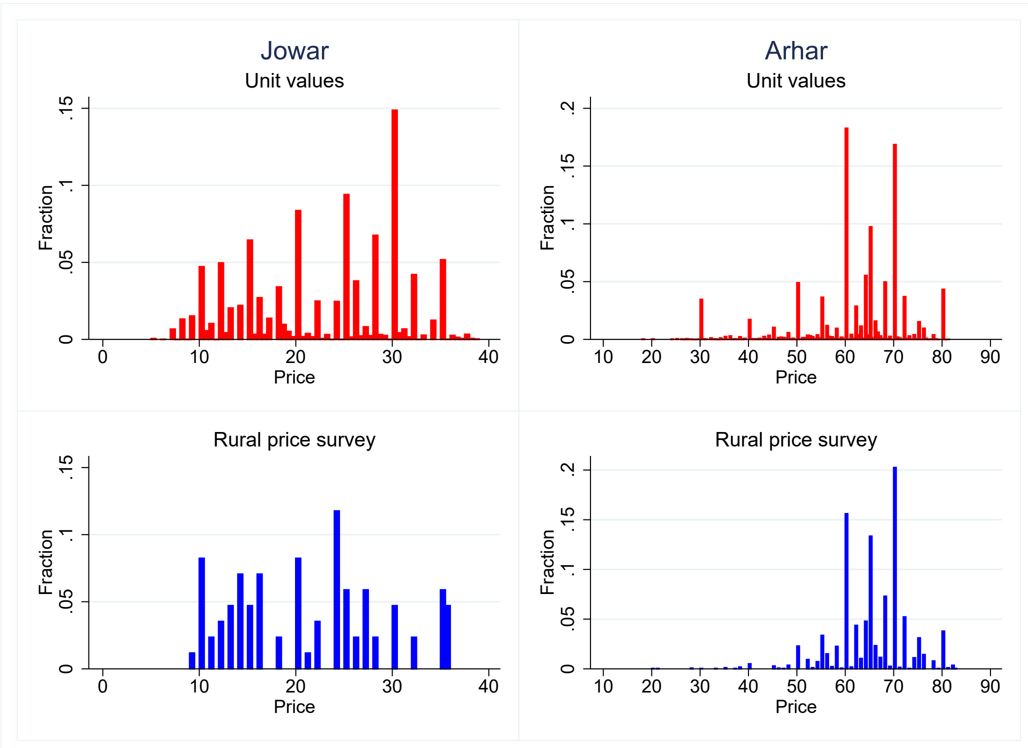
When constructing a measure of price risk for each good category I do not want to use variations that are due to changes in the item-level composition of consumption within that good category. I therefore consider the price variation of the most widely consumed item in each good category for each sub-region (for example 'chicken' is often the most widely consumed item in the 'meat & fish' category). Within sub-region variations over time may be spurious if a low share of the population buys the goods, as the set of buying households could vary substantially over time, I therefore only use sub-regions in which at least 30% of households report buying the good in 2011-2012 to compute the average coefficient of variation. One could also apply this threshold at the quarter∗sub-region level to avoid using variations from periods during which few firms buy the good. This isn't necessary in this context as there is limited seasonality in consumption of these goods, as shown in Tables A14 and A15.

Figure A9: Distribution of unit values and prices: rice and wheat



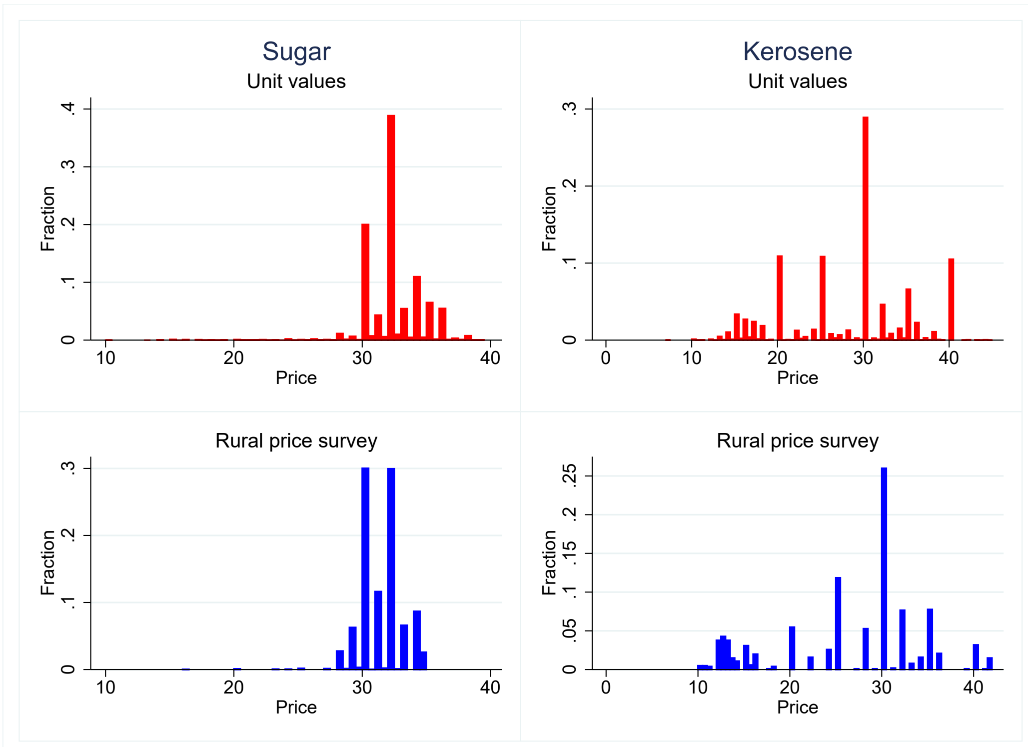
The top (red) panels present the distribution of household level unit values obtained from the NSSO consumption survey, the bottom (blue) panel the distribution of prices in the Rural Price Collection survey. In both cases I exclude observations above the 99th percentile from the graph.

Figure A10: Distribution of unit values and prices: jowar (coarse cereals) and arhar (pulses)



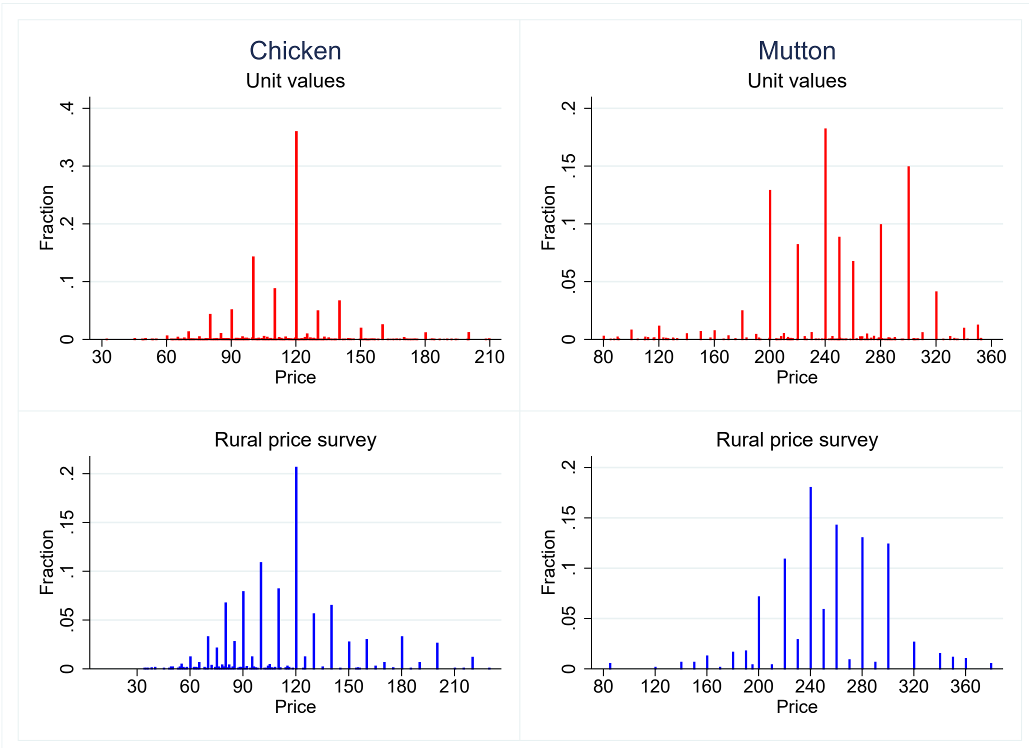
The top (red) panels present the distribution of household level unit values obtained from the NSSO consumption survey, the bottom (blue) panel the distribution of prices in the Rural Price Collection survey. In both cases I exclude observations above the 99th percentile from the graph

Figure A11: Distribution of unit values and prices: sugar and kerosene



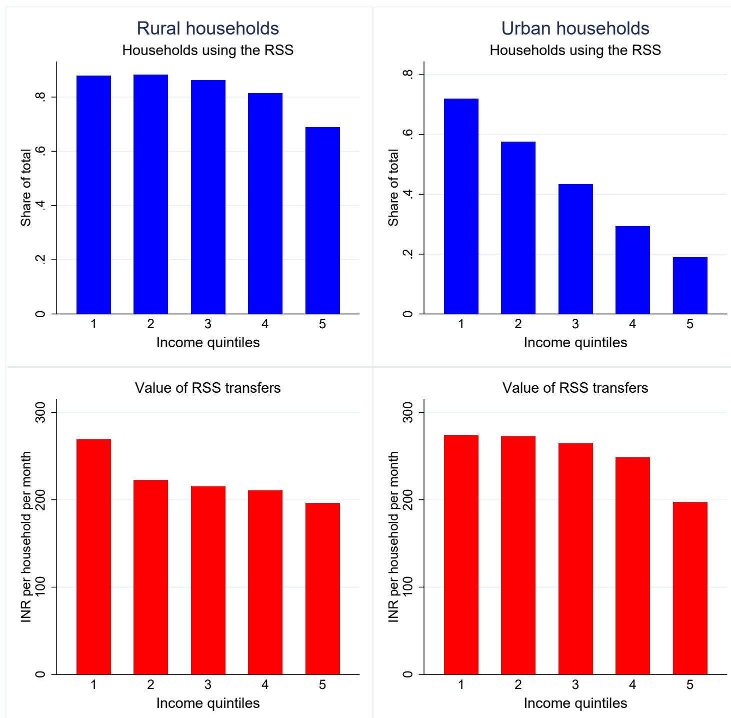
The top (red) panels present the distribution of household level unit values obtained from the NSSO consumption survey, the bottom (blue) panel the distribution of prices in the Rural Price Collection survey. In both cases I exclude observations above the 99th percentile from the graph

Figure A12: Distribution of unit values and prices: chicken and mutton (meat products)



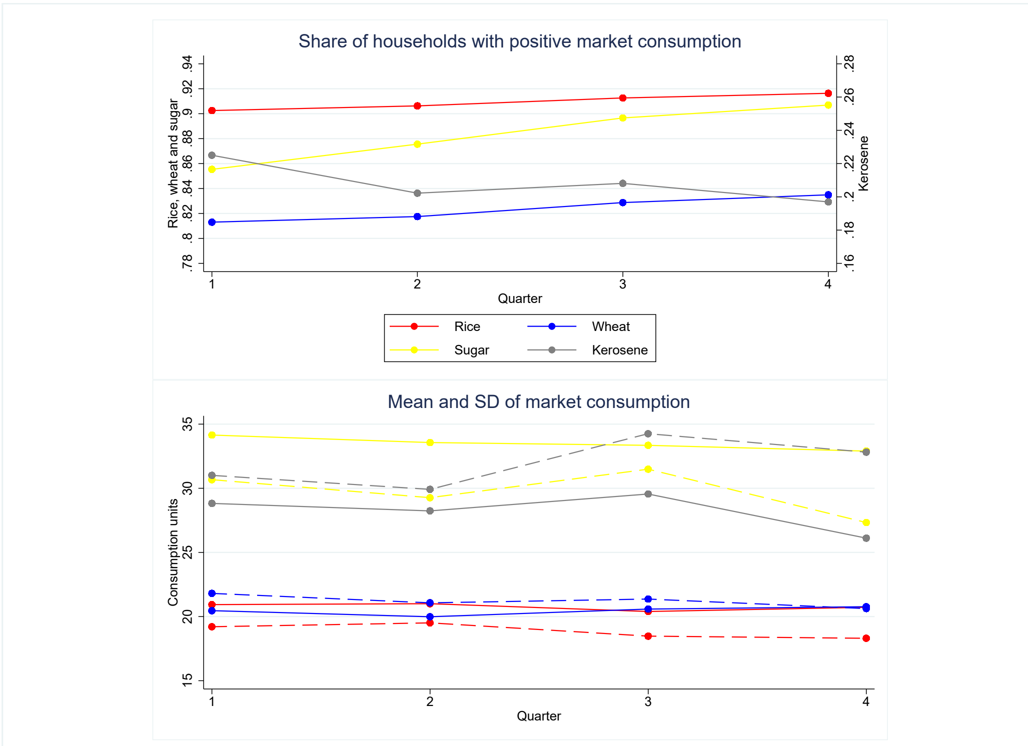
The top (red) panels present the distribution of household level unit values obtained from the NSSO consumption survey, the bottom (blue) panel the distribution of prices in the Rural Price Collection survey. In both cases I exclude observations above the 99th percentile from the graph

Figure A13: Use of ration shop system in urban and rural areas



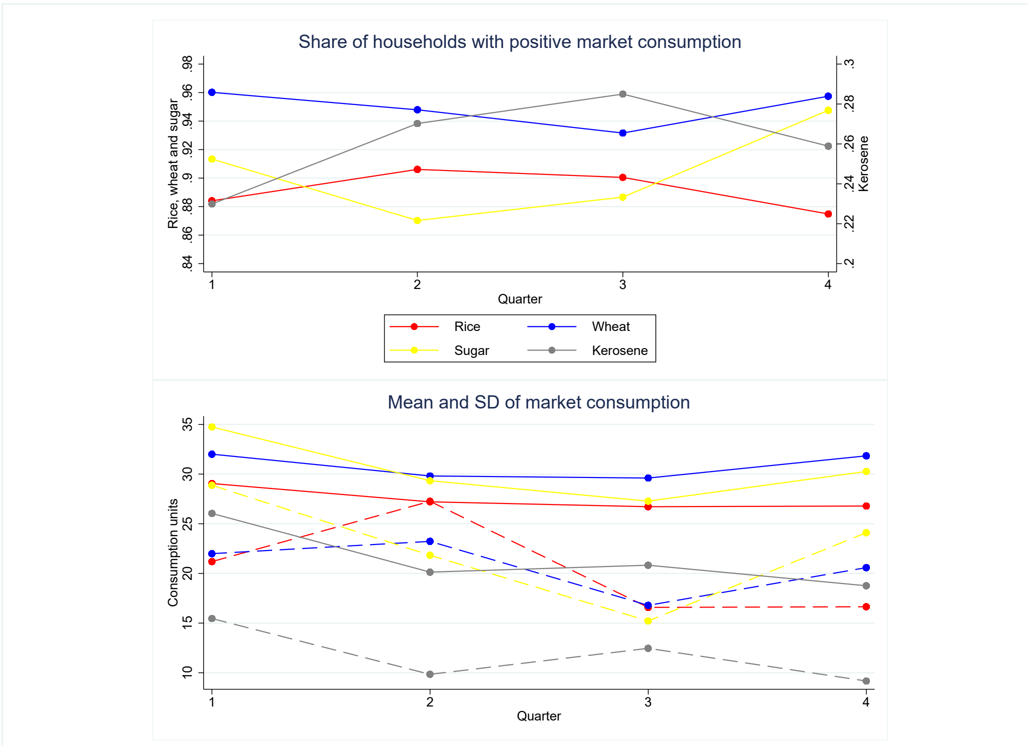
Each graph plots the distribution of a variable by quintile of total expenditure per capita. The top graphs plots the share of households that use the RSS, the bottom graphs the value of RSS transfers (conditional on using the RSS). Graphs on the left include all urban households, graphs on the right all rural households, and quintiles are defined by sub-sample. I use the NSSO's classification of areas as urban or rural. Applying state-level poverty lines 22% of the population is categorized as poor, so most households in the top four quintiles are non-poor. Consumption from ration shops and expenditure per capita are reported by households in the NSSO consumption survey, see the text for a description of the data used.

Figure A14: Seasonality in consumption



The top graphs plots the share of households that consumes each good from the market in each quarter, the bottom graph plots the average (solid lines) and standard deviation (dashed lines) of consumption of each good from the market in each quarter, restricting the sample to households consuming positive amounts. Units in the second graph are kilos for rice and wheat, 100's of grams for sugar and 100's of milliliters for kerosene. All variables are reported by households in the NSSO consumption survey, see the text for a description of the data used.

Figure A15: Seasonality in consumption, biggest sub-region (Uttar Pradesh South)



The top graphs plots the share of households that consumes each good from the market in each quarter, the bottom graph plots the average (solid lines) and standard deviation (dashed lines) of consumption of each good from the market in each quarter, restricting the sample to households consuming positive amounts. Units in the second graph are kilos for rice and wheat, 100's of grams for sugar and 100's of milliliters for kerosene. The sample consists of all households in the most populated sub-region, Uttar Pradesh South (rural). All variables are reported by households in the NSSO consumption survey, see the text for a description of the data used.

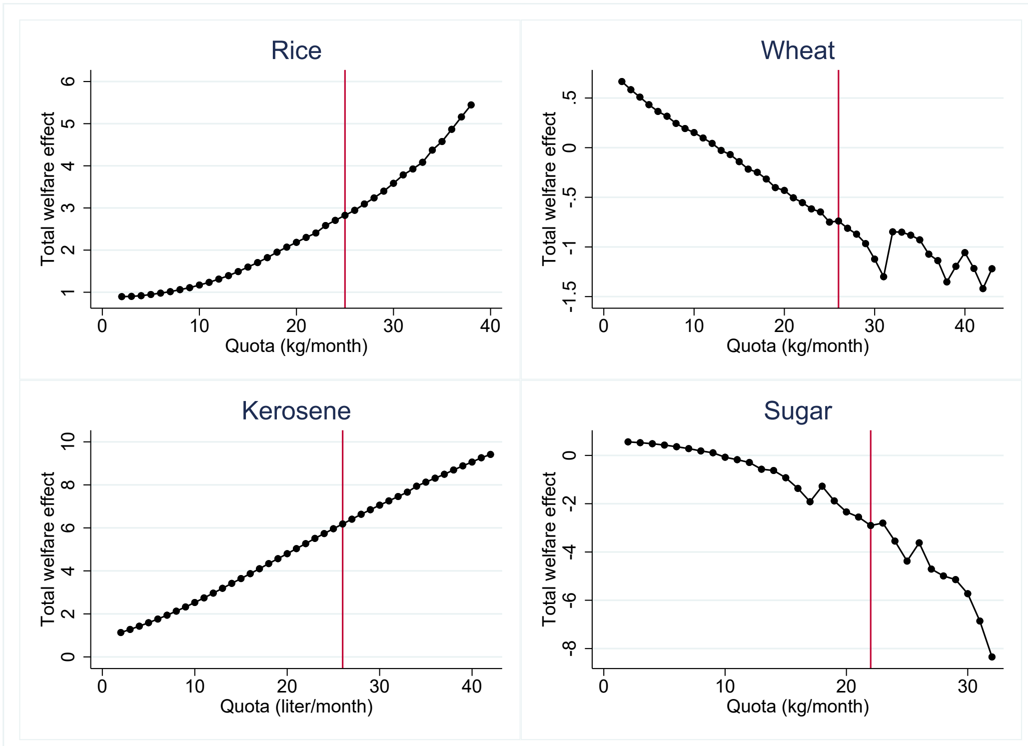
A5 Results section

A5.1 Results by region

Figures A16 and A17 plot the welfare effect of introducing a RSS for each quota level for each good category separately. Table A3 presents the welfare effect of introducing a RSS for each good in each of the 15 largest Indian states separately. Introducing a RSS is welfare-increasing for at least one cereal type in all states, but the cereal with the highest welfare effect differs across states in line with different regional preferences : it is typically rice in the North East and South, coarse cereals in the West and wheat in the North. Including kerosene in the RSS is welfare increasing in all states. Results also suggest introducing other goods in the RSS could be welfare-increasing in some states but in all cases the welfare gains for these goods are small compared to those for cereals and kerosene.

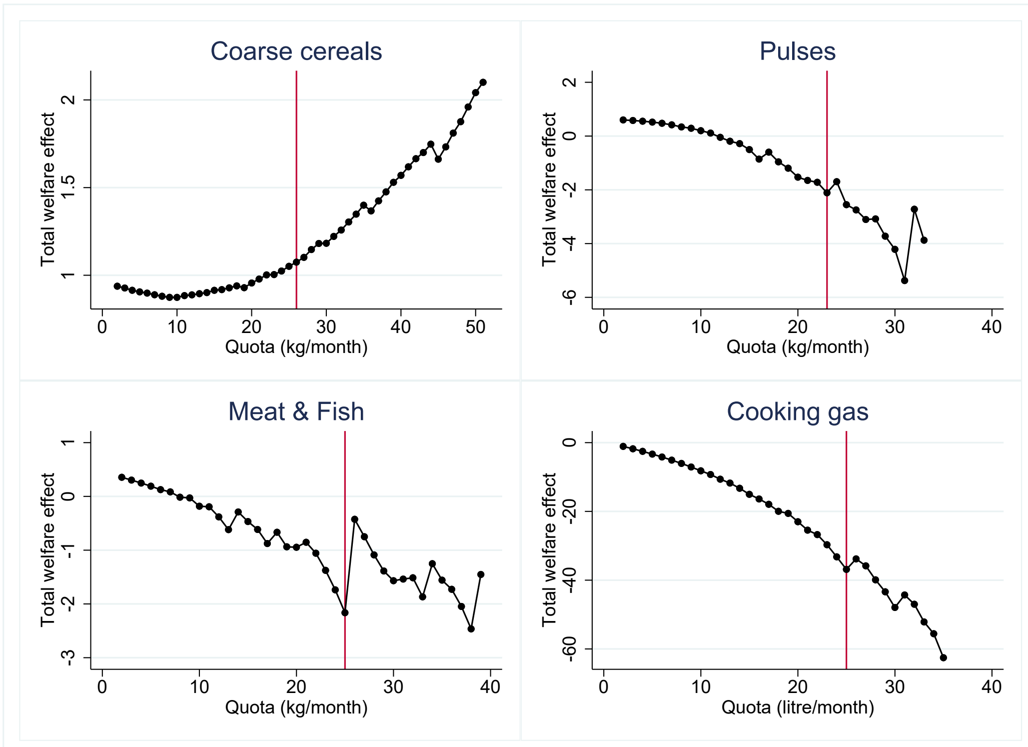
Figure A18 and Table A4 present results separately for urban and rural households. Historically the Indian government has provided urban and rural households with differential access to goods in ration shops. Coverage of rural areas in particularly was much poorer until the mid 90s, when the opening of new ration shops in rural areas lead to similar levels of usage of ration shops in rural and urban areas (Himanshu, 2013b, see also Figure A13). We see that welfare gains for rice are larger in rural than in urban areas and gains for wheat and coarse cereals come mostly from urban areas. These differences reflect the fact that a higher share of the population is urban in states in which wheat and coarse cereals are the main staple; they reinforce the conclusion that different regions should include different cereals in the ration shops. Gains for kerosene are 25% larger in urban areas, reflecting the fact that kerosene is by far the main energy source for poor households in urban areas but less so in rural areas, where biofuels play a larger role (Khandker *et al.*, 2010).

Figure A16: Welfare effects by quota level



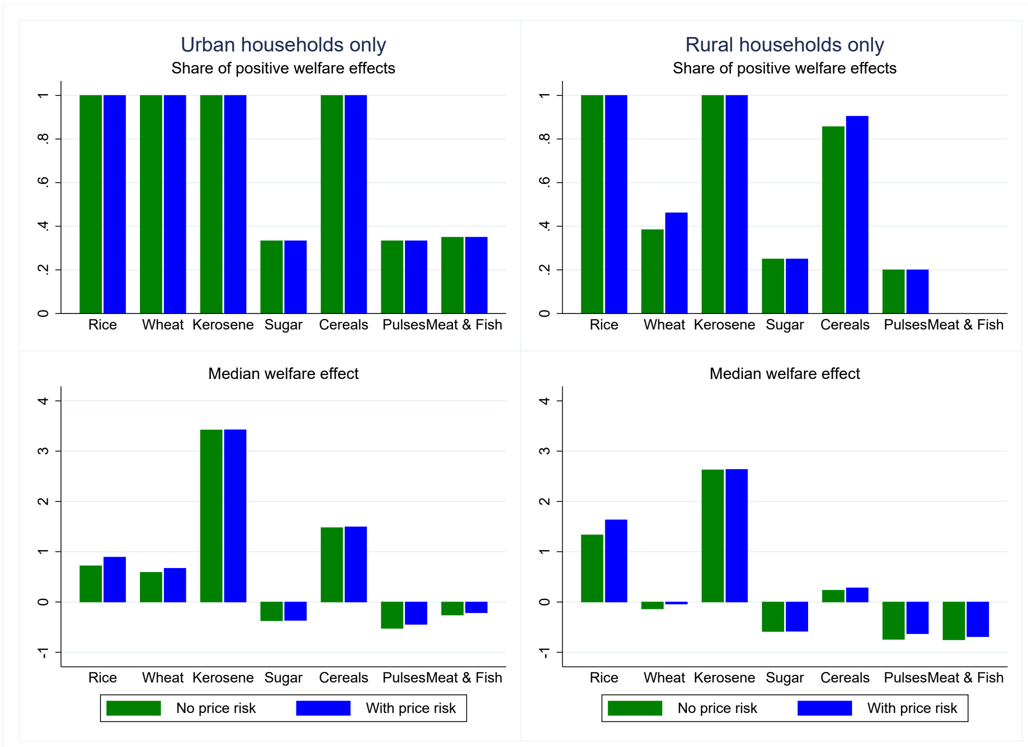
Each graph plots the calibrated total welfare effect (expression (5)) of introducing a ration shop system on the y axis as a function of the quota level on the x axis. Quota levels are measure in kilos or litres per month, welfare effects are measured in INR per INR raised. The red line indicates the median consumption level in the population.

Figure A17: Welfare effects by quota level (2)



Each graph plots the calibrated total welfare effect (expression (5)) of introducing a ration shop system on the y axis as a function of the quota level on the x axis. Quota levels are measure in kilos or litres per month, welfare effects are measured in INR per INR raised. The red line indicates the median consumption level in the population. The maximum quota level corresponds to the 75th percentile of the distribution of consumption.

Figure A18: Welfare effect of rations shop systems: rural vs urban



Graphs on the right are obtained on the sample of urban households only, graphs on the left on the sample of rural households only. The top panels present the share of quotas below the median total consumption levels for which the welfare effect of introducing a RSS is positive. The second panels present the median welfare effect of introducing a RSS across quota levels, units are utils of the same social welfare function for all goods. The green bars correspond to the welfare effect in a world without price risk - expression (3) - and the blue bars correspond to the total welfare effect in a world with price risk - expression (5).

Table A3: Welfare effect of introducing a RSS, state by state

State	Rice			Wheat			Kerosene			Sugar			Coarse cereals			Pulses			Meat & fish		
	q25	> 0	*med*	*q25*	> 0	*med*	*q25*	> 0	*med*	*q25*	> 0	*med*	*q25*	> 0	*med*	*q25*	> 0	*med*	*q25*	> 0	*med*
Assam	6.57	1	4.69	-2.98	0	-3.01	1.94	1	2.00	-0.11	0.50	0.012	0.81	1	0.81	-0.14	0.38	-0.14	0.14	0.81	0.24
Bihar	1.27	1	1.52	0.036	0.82	0.58	1.26	1	1.26	-1.57	0.13	-1.27	-3.95	0	-2.98	-0.31	0.33	-0.56	-2.77	0	-2.70
Gujarat	0.83	1	0.89	-4.70	0	-4.31	3.23	1	3.13	-1.44	0.15	-0.89	4.11	1	4.30	1.09	1	1.09	0.60	0.83	0.46
Jharkand	2.83	1	2.64	-5.72	0	-4.09	3.10	1	3.27	-4.43	0	-3.55	8.41	1	8.41	-1.00	0.14	-1.14	-4.54	0	-3.47
Karnataka	0.19	0.73	0.20	-0.97	0.27	-0.33	4.58	1	4.84	0.010	1	0.54	4.08	1	4.08	0.58	0.77	0.58	-2.23	0	-1.85
Kerala	-1.74	0	-1.62	-1.12	0.053	-1.12	1.44	1	1.44	-0.37	0.36	-0.25	-4.59	0	-3.78	-0.84	0.12	-0.84	0.31	0.71	0.31
MP	0.69	1	0.56	-1.73	0.33	-0.84	4.43	1	4.59	-2.55	0.13	-1.32	1.21	1	1.23	0.83	1	0.95	0.25	1	0.76
Maharashtra	-0.83	0.22	-0.97	-2.31	0.063	-1.74	3.89	1	4.21	-0.80	0.18	-0.69	1.84	1	2.01	0.15	0.73	0.25	-0.12	0.69	0.080
Orissa	6.26	1	4.57	-3.32	0	-4.79	3.15	1	3.15	-2.58	0	-2.13	13.4	1	12.0	-1.20	0.27	-1.20	-3.84	0	-2.70
Punjab	0.43	1	0.51	0.23	1	0.43	2.89	1	3.02	-0.90	0.077	-0.90	-0.98	0	-1.33	-0.084	0.50	0.023	0.057	0.81	0.16
Rajasthan	-1.16	0	-1.16	-0.078	0.65	0.24	4.45	1	4.32	-3.10	0	-2.38	2.17	1	2.48	-0.037	0.57	0.11	-1.09	0	-0.83
TN	2.87	1	2.87	-0.44	0.14	-1.52	2.23	1	2.23	-0.13	0.067	-0.83	1.51	1	1.64	-0.93	0.18	-0.93	-0.79	0	-0.67
UP	1.47	1	1.84	2.04	1	1.57	3.03	1	3.03	-1.67	0.13	-0.76	0.38	1	0.27	-3.54	0	-2.04	0.54	1	0.54
WB	3.18	1	2.78	-0.89	0	-1.28	1.87	1	1.87	-1.71	0.056	-1.91	5.39	1	4.87	-0.93	0.20	-0.93	-1.02	0.13	-0.91

This table present the welfare effect of introducing a RSS (sum of expressions (3) and (5)) in each state separately. For each good considered the first column presents the welfare effect for a quota equal to the 25th consumption percentile, the second column the share of these welfare effects that are positive and the third column the median welfare effect for quotas below the 50th consumption percentile. Cooking gas is excluded from the table as the welfare effect of introducing a RSS for cooking gas is never positive in all states.MP stands for Madhya Pradesh, AP for Andhra Pradesh, TN for Tamil Naud, UP for Uttar Pradesh and WB for West Bengal. See the text for a description of the method and data used.

Table A4: Welfare effect of introducing a RSS, urban and rural areas separately

	Urban areas			Rural areas		
Quota (Consumption percentile)	10	25	50	10	25	50
Rice	0.84	0.88	1.21	0.91	1.52	3.08
Wheat	0.81	0.70	1.04	0.53	0.28	-0.74
Kerosene	2.52	3.50	4.80	1.68	2.50	4.06
Sugar	0.48	-0.12	-1.48	0.10	-0.66	-2.55
Coarse cereals	1.27	1.40	2.08	0.61	0.40	-0.070
Pulses	0.35	-0.27	-1.73	0.080	-1.10	-1.86
Meat & fish	0.33	0.15	-0.55	-0.17	-0.89	-1.50
Cooking gas	-3	-8.40	-17.3	-8.71	-18.6	-29.5

This table present the welfare effect of introducing a RSS in a world with price risk (sum of expressions (3) and (5)) at quota levels equal to the 10th, 25th or 50th percentiles of the total distribution of consumption for the good. Relative risk aversion is set equal to 6 for poor households and 2.13 for non-poor households (so that average risk aversion remains at 3) in all columns, in the last column I also allow for a different level of price risk for poor and non-poor households. See the text for a description of the method and data used.

A5.2 Robustness checks

Table A5 presents results obtained using alternative values of households' demand elasticities. I first set demand elasticities equal across all goods, using values that bias against finding a welfare effect in the first three columns (taking the lowest values for the price and income elasticities, -0.8 and -0.1, from the estimates used at baseline), and then using values that bias in favor of finding a welfare effect in columns 3-6 (taking the highest values of -0.2 for the price elasticity and 0.7 for the income effect). The calibrated welfare effects of introducing a RSS are, as expected, slightly lower than the baseline in the first three columns, and slightly higher in the next three columns. In the last three columns I use the values estimated by Deaton *et al.* (1994) for food commodities (unfortunately no alternative estimates of demand elasticities for kerosene and cooking gas are available in India). The estimates used for the price and income elasticities are: for rice -0.55 and 0.67, for wheat -1.32 and 1.12, for sugar -0.31 and 0.65, for coarse cereals -0.36 and 0.29 and for pulses -0.52 and 0.67. The price and income elasticities estimated by Deaton *et al.* (1994) tend to be a bit larger in absolute values than those I use at baseline in the paper. For normal goods a stronger price effect tends to increase the efficiency cost of a RSS but a stronger income effect tends to decrease it, results in Table A5 suggest these two effects cancel out: the results in the last three columns are very similar to the baseline results presented in Table 4.

In Table A6 I present results obtained by dropping potential outlier values: for each good households consuming more than the 99th percentile of consumption (first three columns) or more than the 95th percentile of consumption (last three columns) are dropped from the calculations. Results are very similar to those in Table 4. The total welfare effect decreases for wheat (the good with the highest right-scale parameter at baseline), but the key results - positive and large welfare effects for rice, coarse cereals and particularly kerosene, negative average effects for meat & fish, sugar and pulses - are unchanged. Table A7 presents results for the main individual commodities in the 'coarse cereals' (jowar), 'pulses' (arhar) and 'meat and fish products' (chicken) good categories. Results for these commodities are similar to the baseline results obtained for the good category they belong to, note that the welfare gains from introducing a RSS for jowar are now higher than those for rice. Table A8 presents results regarding the total welfare effect of introducing a ration shop system in a world with for home production.The first three columns assume that households' home production endowments are equal to their consumption from home production, the last three columns predict households' home production endowments using information about their land (see section A4.2 above for a description of the method used).

Table A9 presents results obtained using different values for the coefficient of relative risk aversion. The baseline used in the paper is 3, in this Table the value is 1 in columns 1-3, 2 in columns 3-6, 4 in columns 4-9. The welfare effects increase with relative risk aversion, as expected, but the total welfare effects do not change substantially. In columns 10-12 I illustrate how very high values of risk aversion affect results by using a value of 10. This increases welfare effects for rice and wheat, the two goods with high price variation, particularly at high quota levels. The insurance effect when the quota is at the 50th percentile is now 50% higher than the redistribution for rice (results separately for the insurance and the redistribution effects are not shown). Finally in columns 13-15 I allow for different price risk levels for the poor and the non-poor and double the value of the risk aversion coefficient for the poor, lowering that of the non-poor so that average relative risk aversion is equal to 3. This increases the welfare effect for the cereals slightly (by 1-4%) but leaves other effects unchanged. Note that the ranking of welfare effects across goods is the same regardless of the value of the coefficient of relative risk aversion used.

Finally Tables A10 and A11 explore the effect of changing the normative parameters that enter the expressions in the paper, those reflecting government preferences for redistribution. In Table A10 I vary the value of the marginal social welfare weight of poor households (g_p, set at 2 at baseline), leaving that of the non-poor (g_{np}) unchanged at its baseline level of 1: I use a value of 1.5 in the first three columns and 4 in the last three columns. Increasing poverty aversion increases the magnitude of the effects, as expected, but does not change the sign of the welfare effects or the ranking of effects across goods. In Table A11 I consider alternative classifications of households as poor or non-poor by increasing or decreasing the state-level poverty lines by 5, 10 or 20%. This varies the share of poor households in the population substantially, from 10% to 36%. Welfare effects of introducing a RSS vary they tend to increase as the poverty line increases, reflecting the fact that the consumption patterns of households do not vary much across the second, third and fourth deciles of the income distribution, but the key results remain: gains are always highest for kerosene, followed by the three cereal types. They are never positive for the other goods considered except at low quota levels with high poverty lines.

Table A5: Welfare effect of introducing a RSS, varying demand elasticities

	Equal for all goods (1)			Equal for all goods (2)			Deaton (1994) estimates		
Quota (Consumption percentile)	10	25	50	10	25	50	10	25	50
Rice	0.90	1.22	2.87	0.93	1.36	3.28	0.91	1.26	2.90
Wheat	0.58	0.22	-0.85	0.65	0.44	0.33	0.59	0.27	-0.60
Kerosene	2.52	3.85	6.16	2.55	3.90	6.23			
Sugar	0.090	-0.97	-2.99	0.35	-0.44	-2.04	0.25	-0.65	-2.40
Coarse cereals	0.90	0.89	1.08	0.89	0.85	0.97	0.90	0.88	1.04
Pulses	0.020	-1.03	-2.40	0.59	0.020	-0.63	0.23	-0.64	-1.74
Meat & fish	-0.18	-0.92	-2.81	0.44	0.20	-0.42	0.16	-0.30	-1.49
Cooking gas	-8.79	-21.5	-39.7	-7.38	-17.9	-32.9			

This table present the welfare effect of introducing a RSS in a world with price risk (sum of expressions (3) and (5)) at quota levels equal to the 10th, 25th or 50th percentiles of the total distribution of consumption for the good. In the first three columns I set demand parameters ϵ and η equal for all goods, in the middle three columns I set risk aversion equal to 2, in the last three columns risk aversion is equal to 4. See the text for a description of the method and data used.

Table A6: Welfare effect of introducing a RSS, dropping high consumption levels

	Dropping top 1%			Dropping top 5%		
Quota (Consumption percentile)	10	25	50	10	25	50
Rice	0.81	1.09	2.55	0.62	0.93	2.61
Wheat	0.49	0.21	-0.91	0.11	-0.21	-1.46
Kerosene	2.74	3.98	6.15	3.07	4.72	7.64
Sugar	0.11	-0.77	-3.42	-0.35	-1.33	-4.85
Coarse cereals	0.91	0.88	1.01	0.90	0.85	0.94
Pulses	0.090	-1.05	-2.66	-0.40	-1.66	-4
Meat & fish	-0.070	-0.77	-2.84	-0.27	-1.15	-4.55
Cooking gas	-8.37	-18.5	-38.9	-9.09	-20.8	-47.8

This table present the welfare effect of introducing a RSS in a world without price risk and home production (sum of expressions (3) and (5)) at quota levels equal to the 10th, 25th or 50th percentiles of the total distribution of consumption for the good. In the first three columns I drop households consuming more than the 99th percentile of consumption from the sample used in the calibration for each good, in the last three columns I drop households consuming more than the 95th percentile of consumption. See the text for a description of the method and data used.

Table A7: Results for individual commodities

	Redistribution effect			Insurance effect			Total effect		
Quota (Consumption percentile)	10	25	50	10	25	50	10	25	50
Jowar	1.24	1.73	3.84	0.020	0.060	0.24	1.26	1.80	4.07
Arhar	-0.52	-1.50	-3.84	0.020	0.030	0.080	-0.50	-1.47	-3.76
Chicken	-2.53	-4.44	-7.24	0.020	0.040	0.060	-2.51	-4.40	-7.18

Jowar is the most commonly consumed commodity in the 'coarse cereals' good category, Arhar the most commonly consumed commodity in the 'pulses' category, and Chicken in the 'meat and fish products' category. The first three columns present the welfare effect of introducing a RSS in a world without price risk (expression (3)) at quota levels equal to the 10th, 25th or 50th percentiles of the total distribution of consumption for the good. The middle three columns present the insurance effect of introducing a RSS in a world with price risk (expression (5), and the last three columns are the sum of the two effects (expression (3) plus expression (5)). See the text for the description of the method and data used.

Table A8: Welfare effect of introducing a RSS, with home production

	Naive endowments			Estimated endowments		
Quota (Consumption percentile)	10	25	50	10	25	50
Rice	0.90	1.20	2.65	0.87	1.16	2.59
Wheat	0.58	0.24	-0.80	0.58	0.23	-0.83
Kerosene	2.53	3.87	6.18	2.53	3.87	6.18
Sugar	0.11	-0.92	-2.90	0.11	-0.92	-2.90
Coarse cereals	0.90	0.88	1.04	0.90	0.88	1.05
Pulses	0.11	-0.87	-2.14	0.11	-0.86	-2.11
Meat & fish	-0.020	-0.62	-2.17	-0.010	-0.62	-2.16
Cooking gas	-8.20	-20.0	-36.9	-8.20	-20.0	-36.9

This table present the welfare effect of introducing a RSS in a world without price risk and home production (sum of expressions (3), (5) and (A17)) at quota levels equal to the 10th, 25th or 50th percentiles of the total distribution of consumption for the good. In the first three columns I use consumption from home production to proxy for home production endowments, in the last three columns I estimate home production endowments - see the text for a description of the method and data used.

Table A9: Welfare effect of introducing a RSS, varying risk aversion

Coefficient of risk aversion	1			2			4			10			6 and 2.12		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
Quota (Consumption percentile)	10	25	50	10	25	50	10	25	50	10	25	50	10	25	50
Rice	0.88	1.11	2.26	0.89	1.17	2.54	0.92	1.30	3.11	0.99	1.68	4.80	0.91	1.27	2.99
Wheat	0.58	0.22	-0.90	0.58	0.23	-0.82	0.59	0.26	-0.66	0.61	0.34	-0.16	0.59	0.25	-0.71
Kerosene	2.53	3.86	6.17	2.53	3.87	6.18	2.53	3.87	6.19	2.54	3.89	6.24	2.53	3.88	6.20
Sugar	0.11	-0.93	-2.91	0.11	-0.93	-2.91	0.11	-0.92	-2.90	0.12	-0.91	-2.87	0.11	-0.92	-2.89
Coarse cereals	0.90	0.87	1.02	0.90	0.88	1.05	0.91	0.90	1.10	0.93	0.95	1.26	0.91	0.90	1.12
Pulses	0.080	-0.92	-2.25	0.10	-0.89	-2.18	0.13	-0.82	-2.04	0.24	-0.62	-1.61	0.14	-0.80	-1.99
Meat & fish	-0.030	-0.64	-2.23	-0.020	-0.63	-2.20	-0.010	-0.60	-2.13	0.030	-0.53	-1.93	0	-0.59	-2.09
Cooking gas	-8.21	-20.0	-37.0	-8.20	-20.0	-36.9	-8.19	-19.9	-36.8	-8.14	-19.8	-36.5	-8.17	-19.9	-36.7

COMPLETE This table present the welfare effect of introducing a RSS in a world with price risk (sum of expressions (3) and (5)) at quota levels equal to the 10th, 25th or 50th percentiles of the total distribution of consumption for the good. In the first three columns I set demand parameters ϵ and η equal for all goods, in the middle three columns I set risk aversion equal to 2, in the last three columns risk aversion is equal to 4. See the text for a description of the method and data used.

Table A10: Welfare effect of introducing a RSS, varying government preferences

Weight on the poor		1.5			4	
Quota (Consumption percentile)	10	25	50	10	25	50
Rice	2.65	3.42	7.21	0.47	0.69	1.73
Wheat	1.73	0.67	-2.58	0.30	0.14	-0.28
Kerosene	7.59	11.6	18.5	1.27	1.94	3.10
Sugar	0.33	-2.78	-8.72	0.060	-0.46	-1.45
Coarse cereals	2.70	2.63	3.11	0.46	0.45	0.57
Pulses	0.26	-2.72	-6.65	0.080	-0.39	-0.97
Meat & fish	-0.070	-1.90	-6.62	0	-0.30	-1.05
Cooking gas	-24.6	-60.0	-111	-4.09	-9.96	-18.4

This table present the welfare effect of introducing a RSS in a world with price risk (sum of expressions (3) and (5)) at quota levels equal to the 10th, 25th or 50th percentiles of the total distribution of consumption for the good. In the first three columns I set demand parameters ϵ and η equal for all goods, in the middle three columns I set risk aversion equal to 2, in the last three columns risk aversion is equal to 4. See the text for a description of the method and data used.

Table A11: Welfare effect of introducing a RSS: changing poverty lines

	Higher poverty line									Lower poverty line								
	+1%			+5%			+10%			-1%			-5%			-10%		
Quota	10	25	50	10	25	50	10	25	50	10	25	50	10	25	50	10	25	50
Rice	0.91	1.28	3.00	0.92	1.33	3.33	0.92	1.35	3.62	0.89	1.14	2.43	0.88	1.11	2.24	0.86	1.02	1.81
Wheat	0.60	0.23	-0.78	0.61	0.18	-1.02	0.67	0.21	-0.98	0.59	0.27	-0.60	0.60	0.35	-0.35	0.61	0.42	-0.12
Kerosene	2.77	4.28	6.92	2.99	4.66	7.55	3.40	5.37	8.81	2.29	3.42	5.36	2.05	2.99	4.61	1.59	2.21	3.26
Sugar	0.13	-0.95	-3.03	0.15	-0.93	-3.00	0.22	-0.83	-2.84	0.060	-0.99	-2.93	0.059	-0.93	-2.73	0.044	-0.81	-2.32
Coarse cereals	0.94	0.95	1.21	0.92	0.92	1.16	0.96	1.04	1.49	0.79	0.65	0.61	0.69	0.50	0.24	0.65	0.48	0.20
Pulses	0.15	-0.83	-2.04	0.18	-0.78	-1.88	0.25	-0.70	-1.60	0.066	-0.89	-2.20	0.060	-0.84	-2.14	0.064	-0.70	-1.84
Meat & fish	0.044	-0.55	-2.07	0.19	-0.31	-1.66	0.36	-0.032	-1.04	-0.095	-0.73	-2.35	-0.11	-0.70	-2.24	-0.16	-0.69	-2.05
Cooking gas	-9.14	-22.3	-41.2	-10.0	-24.4	-45.1	-11.5	-28.2	-52.2	-7.10	-17.3	-31.9	-6.10	-14.8	-27.3	-4.12	-10.0	-18.4

This table present the welfare effect of introducing a RSS (sum of expressions (3) and (5)) in each state separately. I vary the poverty line used across columns. In the first half of the table I increase the poverty line by 1%, 5% and 10%, in the second half I decrease it by 1%, 5% and 10%. See the text for a description of the method and data used.

A6 Discussion section

I use results from Table 3 in Niehaus *et al.* (2013) to proxy for the government's targeting capacity $\hat{\pi} - \pi$. In their context the share of statutorily poor (or 'eligible') households π is 5071/13493 = 0.3758 and the probability that a household is statutorily poor conditional on being considered poor by the state government ('Has BPL card'), $\hat{\pi}$ is 4419/10281 = 0.4298. I use the value $\frac{\hat{\pi}}{\pi}$ = 0.4298/0.3758= 1.1436 in the calibration, this corresponds to a 14% increase in the inclusion rate compared to a universal transfer. Table A12 presents the results in the first three columns. In the remaining columns I increase the (relative) inclusion rate to 20% and 30%. Finally Table A13 presents results for a leakage rate of 3%, 5% and 7%.

Table A12: Welfare effect of introducing a RSS, limited targeting capacity

Targeting capacity	14%			20%			30%		
Quota (Consumption percentile)	10	25	50	10	25	50	10	25	50
Rice	0.54	-0.27	-1.80	0.38	-0.92	-3.78	0.12	-1.99	-7.09
Wheat	0.25	-0.61	-4.53	0.11	-0.98	-6.15	-0.13	-1.60	-8.85
Kerosene	1.60	2.40	4.11	1.20	1.77	3.22	0.54	0.72	1.73
Sugar	-1.34	-3.72	-7.49	-1.96	-4.92	-9.46	-2.99	-6.92	-12.7
Coarse cereals	0.49	-0.11	-1.06	0.31	-0.54	-1.98	0.010	-1.26	-3.51
Pulses	-1.76	-4.14	-7.22	-2.56	-5.54	-9.41	-3.90	-7.89	-13.1
Meat & fish	-0.79	-1.93	-4.50	-1.13	-2.49	-5.50	-1.68	-3.43	-7.17
Cooking gas	-9.77	-23.7	-43.6	-10.4	-25.3	-46.5	-11.6	-28	-51.3

This table present the welfare effect of introducing a RSS in a world in which the government has limited targeting capacity: I assume the government's alternative use of funds is a transfer that reaches the poor with probability $\hat{\pi} > \pi$. In the first three columns I report results assuming $\frac{\hat{\pi}}{\pi} = 1.14$, as in Niehaus *et al.* (2013), in the middle three $\frac{\hat{\pi}}{\pi} = 1.20$ and in the last three $\frac{\hat{\pi}}{\pi} = 1.30$. See the text for a description of the method and data used.

Table A13: Welfare effect of introducing a RSS, with leakage

Leakage	3%			5%			8%		
Quota (Consumption percentile)	10	25	50	10	25	50	10	25	50
Rice	0.45	-0.78	-5.12	0.16	-2.13	-10.4	-0.14	-3.48	-15.7
Wheat	0.17	-0.93	-6.88	-0.10	-1.71	-11.0	-0.38	-2.50	-15.1
Kerosene	1.35	1.74	2.21	0.57	0.32	-0.44	-0.22	-1.09	-3.09
Sugar	-1.71	-4.89	-11.0	-2.92	-7.53	-16.5	-4.14	-10.2	-21.9
Coarse cereals	0.39	-0.45	-2.40	0.050	-1.35	-4.72	-0.29	-2.24	-7.04
Pulses	-2.28	-5.35	-11.4	-3.87	-8.34	-17.7	-5.47	-11.3	-23.9
Meat & fish	-1.02	-2.44	-6.39	-1.69	-3.65	-9.21	-2.36	-4.87	-12.0
Cooking gas	-10.3	-25.6	-49.0	-11.6	-29.3	-57.0	-13.0	-33.0	-65.1

This table present the welfare effect of introducing a RSS in a world with leakages: for each INR received by households through ration shops I assume the government has to spend $1+\beta$ INR. In the first three columns I report results assuming $\beta = 0.03$, in the middle three $\beta = 0.05$ and the last three $\beta = 0.07$.See the text for a description of the method and data used.

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