WARWICK
THE UNIVERSITY OF WARWICK

Jan 2018 No.358

Do Ration Shop Systems Increase Welfare? Theory and an Application to India

Lucie Gadenne

WORKING PAPER SERIES

Centre for Competitive Advantage in the Global Economy

Department of Economics

CAGE
Competitive Advantage in the Global Economy

E·S·R·C
ECONOMIC & SOCIAL RESEARCH COUNCIL

Do Ration Shop Systems Increase Welfare? Theory and an Application to India

Lucie Gadenne

University of Warwick and Institute for Fiscal Studies*

January 2018

Abstract

In many developing countries households can purchase limited quantities of goods at a fixed subsidized price through ration shops. This paper asks whether these countries' characteristics justify the use of such ration shop systems. I find an equity-efficiency trade-off: an efficiency-maximizing government will never use ration shops but a welfare-maximizing one might, to redistribute and provide insurance. Welfare gains from introducing ration shops are highest for necessity goods with high price risk. I calibrate the model for India and find that ration shops are indeed welfare-improving for three of the four goods sold through the system today.

*I thank Orazio Attanasio, Marco Bassetto, Tim Besley, Richard Blundell, Mirko Draca, Ethan Ligon, Ben Lockwood, Omer Moav, Imran Rasul, Emmanuel Saez, Monica Singhal, as well as seminar participants at the University of Warwick, University College London, Berkeley University, Stanford University, the World Bank Research Group, UC Davis, the European University Institute, McGill University, Paris School of Economics, Zurich University and the IADB for helpful comments.

1 Introduction

Ration shop systems give households a right to purchase some goods at a fixed subsidized price up to a quota level. They are in place in many developing countries today; India's ration shop system alone is used by 70% of its inhabitants - roughly 11% of the world's population. Table 1 presents a non-exhaustive list of countries in which ration shop systems exist, restricted to examples for which estimates of the cost of the program are available. Goods sold in ration shops are typically food and fuel; eligibility to use ration shops varies across countries but universal access is not uncommon.[1]

These systems enable governments to implement a particular form of commodity taxation: by subsidising purchases below a quota level through ration shops and (sometimes) levying a tax on the same good when purchased on the market governments are effectively setting marginal commodity tax rates that increase with amounts consumed. Such non-linear commodity taxes are hard to explain using standard models of taxation; they have been ruled out as unfeasible in most of the literature because governments do not observe commodity consumption at the household level.[2] Perhaps consequently little work has been done to understand the rationale behind the specific commodity taxes and subsidies used by developing countries and inform the ways in which they could be reformed.

In this paper I ask why benevolent governments in developing countries would ever want to use universal-access ration shop systems. I start with the realization that these systems make a form of non-linear commodity taxes (piece-wise increasing taxes) feasible and ask under what conditions these taxes are welfare-increasing. I take into account two particularities of the developing country context that may make ration shops optimal in these countries and not in the developed world: limited government targeting capacity and high commodity price risk. First, governments in developing countries have limited capacity to observe individual incomes - targeting capacity (Besley and Persson, 2013, Jensen, 2016, Kleven *et al.*, 2016); my baseline model assumes the government cannot use income taxes and transfers. Redistribution through commodity taxation is known to be inefficient under general assumptions when income taxes are available (Atkinson and Stiglitz, 1976). However, when income taxes and transfers are costly to implement, ration shop systems may enable governments to redistribute more than linear commodity taxes (*redistribution* motive). Second, high transport costs, under-developed retail markets and regional trade regulations lead to poor spatial market integration in developing countries, as well-documented by the trade literature.[3] Consumer prices consequently co-vary strongly with local supply shocks. I allow for varying producer prices in the model: this introduces a potential *social insurance* motive for the use of ration shops that fix the price of goods up to a quota level.

[1] The history and current functioning of ration systems is well documented in Alderman (2002), Rogers and Coates (2002), Kennedy and Harold (1987).

[2] Linearity is seen by Atkinson and Stiglitz (1980) as a defining characteristic of commodity taxes, and the main difference between direct and indirect taxes "...the essential aspect of the distinction [is] the fact that direct taxes may be adjusted to the individual characteristics of the taxpayer, whereas indirect taxes are levied on transactions irrespective of the circumstance of buyer and seller." (Atkinson and Stiglitz (1980), p 427)

[3] See for example Fackler and Goodwin (2001), Atkin (2013), Atkin and Donaldson (2015), Allen and Atkin (2016).

This paper's first contribution is a model of commodity taxation that takes into account the characteristics of developing countries and considers under what conditions (what types of household and government preferences) ration shop systems are welfare-improving compared to standard linear taxes. I set up a Ramsey-type model of commodity taxation in which households differ in their preferences and incomes and face an exogenous price risk; I allow for the possibility that households consume from their own production to capture the fact that in developing countries some rural households are net producers of agricultural goods.

I obtain general conditions under which ration shop systems (RSS) are welfare-improving. There is a trade-off between efficiency and equity: a revenue-maximizing government will in general not choose to use a RSS because it implements higher marginal prices for households with the highest demand for the good, thereby lowering overall demand. When the government maximizes welfare, however, ration shops become welfare-improving for many goods, and this even when prices are fixed and the only role potentially played by the RSS is redistribution. Intuitively, including normal goods in ration shops enables the government to raise revenues through commodity taxes whilst shielding poor households from the tax, at the cost of increasing the distortions imposed by the tax system. The highest welfare gains from introducing a RSS are obtained for necessities: normal goods widely consumed by poor households. For these goods taxing higher levels of consumption more affects richer households disproportionately and most poor households benefit from the lower prices below the quota. Introducing price risk in the model typically leads to an insurance gain from introducing a RSS, this gain increases with budget shares and the level of risk but decreases when poorer households produce the good at home.

This paper's second contribution lies in the calibration to the Indian context of the model's expressions for the welfare effect of ration shops. These expressions are a function of parameters easily observed in the type of household surveys available in developing countries: the joint distributions of incomes of consumption, budget shares and price variations for each good considered. I calibrate the welfare effect of introducing ration shops for eight types of goods widely consumed by households using India's large 2011-2012 household consumption survey. The survey documents household consumption from ration shops, markets and home production and therefore allows me to simulate the joint distributions of incomes and consumption patterns under different counterfactual tax scenarios. It is available annually; I use past editions to obtain proxies for the level of price risk faced by households.

I find that introducing ration shops is welfare-improving for three goods that are currently distributed through the ration shop system - kerosene, rice and (to a lesser extent) wheat. These three goods are necessities in the Indian context - only consumed slightly more by non-poor than poor households - so there are clear redistributive gains from allowing them to be sold in a RSS. In addition there are substantial insurance gains from using a RSS for rice and wheat, but not for kerosene because kerosene represents a much smaller share of households' budget. Sugar is also distributed through ration shops in India but results suggest this isn't optimal because sugar is a commodity that richer households consume substantially more of and with little price risk. I consider other goods as candidates for inclusion in India's RSS and find welfare gains for coarse cereals (cereals that are staples in some parts of India), but not for any other good.

I then study the impact of relaxing the model's key assumptions. Allowing for some government capacity to target poor households reduces the welfare gains from introducing a RSS. This explains why governments in developed countries with high targeting capacity never use ration shops. In today's India, however, I find that welfare gains from introducing ration shops are still positive for kerosene and cereals once the government's limited targeting capacity is taken into account in the calibration (I use survey estimates of targeting capacity from Niehaus *et al.* (2013)). Allowing for leakages also reduces the welfare gains of introducing a RSS; calibration results suggest these gains are wiped out in the Indian context when more than 6% of the funds allocated to the RSS are lost to administrative or corruption costs.

This paper contributes to the growing literature on public finance in developing countries which considers to what extent optimal tax policy recommendations change when we take into account the specificities of developing countries.[4] I show that under some conditions a form of non-linear commodity taxation that has largely been ignored by the literature is a useful policy instrument in developing countries because of the characteristics of both governments (limited targeting capacity) and markets (high price risk) in these countries. This approach is related to that followed by Best *et al.* (2015) who show that turnover taxes may be part of the optimal tax mix in developing countries because of the specific constraints faced by governments in this context - in their case, high levels of tax evasion.

A large literature considers how governments in developing countries redistribute with limited capacity to observe households' incomes (see Coady *et al.*, 2004, Alatas *et al.*, 2012). This literature has mostly considered commodity subsidies through the lens of the cash-versus-kind debate, focusing on justifications for in-kind redistribution that stem from paternalism (Cunha, 2014), general equilibrium effects on market prices (Coate *et al.*, 1994, Cunha *et al.*, 2017) or concerns regarding food security (Tarozzi, 2005).This paper shows how ration shop systems, a form of in-kind transfers, can be part of a government's optimal policy tools even in the absence of these effects once we take into account the characteristics of governments and markets in developing countries. This approach also allows me to explain why ration shops only exist in these countries and derive expressions to quantify their welfare effects.[5] Governments' limited targeting capacity also motivates many of the calls for developing countries to implement universal basic income schemes (see for example Ghatak, 2016, Ravallion, 2017). The model developed here assumes the government's alternative use of fund is a universal transfer; results therefore allow me to consider under what conditions a

[4]See for example de Paula and Scheinkman (2010), Olken and Singhal (2011), Kleven and Waseem (2013), Kumler *et al.* (2015), Pomeranz (2015), Naritomi (2016), Gerard and Gonzaga (2016), Khan *et al.* (2016), Bachas and Soto (2017), Carrillo *et al.* (2017), Cagé and Gadenne (2017) as well as Emran and Stiglitz (2005), Boadway and Sato (2009), Dharmapala *et al.* (2011) for theoretical work on the topic.

[5]A smaller literature considers how existing ration shop systems can be made more efficient by changing implementation procedures - (see for example Sukhtankar and Niehaus, 2011, Banerjee *et al.*, 2016, 2017) - or studies the effect of recent changes in India's ration shop systems (Khera, 2011a, Khera and Dreze, 2013, Himanshu, 2013, Nagavarapu and Sekhri, 2014).

ration shop system - another program with universal eligibility - is welfare-increasing compared to a scenario in which the government uses only a universal basic income financed by linear commodity taxes.

Finally this paper is the first to consider both the possibility and the welfare properties of piecewise-increasing commodity taxes for general consumption goods. A small literature in public finance has considered non-linear taxation of particular goods, for example housing or education (see Currie and Gahvari, 2008, for a review). This literature assumes the existence of 'indicator goods' - goods preferred by poorer households regardless of their income - and hence opens up the possibility that non-linear commodity taxes on those goods relax the self-selection constraint faced by the optimal income tax problem (Nichols and Zeckhauser, 1982). This paper departs from this literature by studying when non-linear commodity taxes are optimal even in the absence of indicator goods when income taxes are not available.[6] The model's assumptions are thus in the spirit of Ramsey (1927) (exogenous, non taxable income), Diamond (1975) (heterogenous preferences) and Varian (1980) (exogenous price risk). The introduction of non-linear taxes also relates the model to the Mirrleesian optimal income tax tradition and the paper's emphasis on deriving formulas expressed as a function of parameters that can be estimated from standard datasets is similar to Saez (2001).[7]

The paper is organized as follows. Section 2 describes India's ration shop system, focusing on key characteristics that are building blocks of the model. Section 3 sets up the model and derives conditions under which a ration shop system is welfare-improving. Section 4 explains the methodology and data used to calibrate these expressions numerically for India. Section 5 presents the results and section 6 discusses their robustness to relaxing some of the model's key assumptions.

2 Ration shop systems in practice

A ration shop system is a program that gives households the right to purchase a given quota amount of some commodities at a fixed subsidized price. Consumption above the quota must be purchased on the market and market purchases may be taxed. These subsidies are financed through public revenues, in developing countries the bulk of these comes from commodity taxes (see Gordon and Li, 2009). In this section I detail the example of India's ration shop system which I later apply the model to, focusing on key policy and market characteristics that affect the functioning of the RSS and are building blocks of the model developed in section 3.

India's ration shop system, known as the Public Distribution System, has been in existence for over 70 years (see Mooiji, 1999, for more on the history of the public distribution system). The main four commodities sold in the more than 500,000 ration shops in the country are rice, wheat,

[6] Another related paper by Sah (1983) shows that redistribution through commodity taxes is limited by the extent to which budget shares are differentiated along the income distribution. He argues that differences in consumption are too small for much redistribution to be obtained through commodity taxes, and suggests that this is a problem in developing countries which rely heavily on those types of taxes. This paper points out that this result no longer holds once we take into account the fact that developing countries are in practice taxing commodities non-linearly.

[7] See also Sheshinski (1989), Slemrod *et al.* (1994).

kerosene and sugar; when sold on the market these goods are subject to state-level value-added-taxes (VAT).[8] The system is India's largest poverty alleviation program, both in terms of cost (currently 1% of GDP) and reach: 70% of Indian households use ration shops (Khullar, 2017). The central government bears most of the cost of the subsidies but state governments have discretion over which goods to include in the RSS, the eligibility criteria, ration prices, quota amounts and tax rates. Households' capacity to afford food and fuel remains a concern in India today; this concern motivated the passing of the National Food Security Act in 2013.[9] The Act established households' access to commodities at subsidized prices as a legal entitlement and imposed a lower bar (ceiling) on the quota levels (ration prices) that states are allowed to set (Dreze *et al.*, 2015).

Table 2 presents descriptive statistics for each good sold in the ration shop system - see the appendix for a description of the ration shop policies of major Indian states. Panel A shows the range of official quotas and ration prices in place in 2011-2012. Panels B to D show consumption and prices of the goods as reported by households in a nationally representative consumption survey, described below. Comparing Panels A and B we see that the typical official quotas are somewhere between the 25th and 50th percentiles of the distribution of consumption from all sources for rice, wheat and kerosene (though quotas are lower in some states), under the 25th percentile for sugar. The minimum quota level established by the National Food Security Act - 5 kg of cereals per individual per month - is similarly located close to the 25th percentile of distribution of total cereal consumption.[10]

There is substantial anecdotal evidence of corruption in the running of the ration shop system (see for example Planning Commission, 2005, Khera, 2011b, Nagavarapu and Sekhri, 2014). Of interest here is whether the RSS used by households in India resembles the definition - sales of quotas at a fixed subsidized price - used in the model below. Table 2 is reassuring in that respect: we see that quantities purchased and ration prices as reported by households (in Panels B and C) are within the range of official state-level quotas and ration prices in Panel A; I compare reported ration quantities and prices to official quotas in six major states in the appendix and find that they are very close. The system's capacity to provide insurance against price fluctuations, a key component of the model developed below, could however be seriously impaired if ration prices and amounts co-varied with market prices. Hari (2017) finds some evidence going in this direction but Figure 1 suggests the correlations between market conditions and ration quotas and prices are low. Using values reported by households, I plot the district-level relationship between median market price and i) ration prices, ii) share of households using ration shops and iii) average RSS purchases in two Indian states, one in which the system is deemed well-functioning (Andhra Pradesh) and one

[8]Rice wheat and sugar are currently tax-exempt but were taxed at a positive rate in some states until 2005. The average tax is on kerosene 12.5%.

[9]Pachauri *et al.* (2004) estimate that 14% of Indian households are 'extremely energy poor', meaning they barely have enough fuel for one cooked meal per day; the World Bank estimates that a third of Indian households had no access to electricity in 2011 (*World Development Indicators*). The UN's Food and Agriculture Organization (FAO) finds that 195 million individuals in India are under-nourished, roughly 15% of the population.

[10]This quota level corresponds to 20-30 kg per household per month. The average Indian households consumes 54 kg of cereals a month, the median is 43 and the 25th percentile 29.

in which it is thought to be inefficient and corrupt (Bihar) (see Khera, 2011b). In both states we see that ration prices, ration shop use and amounts bought in ration shops are not correlated, or weakly correlated, with market prices. The descriptive evidence suggests that the system is reasonably well implemented overall; I assume perfect implementation in modelling the RSS below but allow for corruption and administration costs (leakages) in a model extension and in the calibration.

Table 2 also shows that there is substantial variation in market prices for all commodities except sugar; in Figure 1 we see that even within a single state and year the mean price of rice doubles from the lowest-price district to the highest-price district. This high level of price variation across areas is in line with evidence for India in Atkin (2013) and can be explained by the fact that local markets are not well integrated because of poor transport infrastructure and taxes and regulations limiting trade across areas[11]. High levels of price risk are a pervasive characteristics of markets in developing countries more generally (see for example Atkin and Donaldson, 2015). Relatedly panel B of Table 2 points to another characteristic of markets in developing countries: a non-negligible share of households produce the goods they consume at home. This affects the welfare cost of market price variations as home production can provide consumers with partial insurance against market price risk. The model developed below considers how allowing for varying market prices affects the welfare effect of ration shop systems and to what extent the existence of home production mitigates their potential social insurance value.

The last panel of Table 2 presents descriptive statistics on total consumption from ration shops for poor and non-poor households, using official state-level poverty lines to define households' poverty status. We see that a large majority of both poor and non-poor households report using the RSS: amongst households using ration shops the monetary value of transfers is roughly 20% higher for the poor than the non-poor. Poor households could be using ration shops more than the non-poor for two reasons. There could be de facto targeting of the RSS even if all households were equally eligible to use ration shops if non-poor households chose not to use them because the goods sold in ration shops are imperfect substitutes for those sold on the market.[12] There could also be targeting by design: state governments decide how much the RSS is targeted, the typical Indian state gives all households a right to purchase goods from ration shops but sets less generous entitlements for non-poor households (see appendix). Figure 2 shows that the limited targeting across households seen in Table 2 is not only due to mis-targeting close to the poverty line, set at the 22nd percentile of the distribution: we see that 65% of households in the fourth income quintile report using ration shops. In the appendix I consider the extent to which states are capable of targeting RSS transfers to the poor by comparing states with different official targeting criteria. I find that households in the richest quintile are only 20% less likely than those in the poorest quintile to use ration shops in the one state (Tamil Nadu) in which all households have the same entitlements, suggesting any ordeals imposed by the system are insufficient to deter most of the non-poor from using it. There is moreover no clear evidence of better targeting amongst states

[11] See Gadenne *et al.* (2017) for a detailled discussion of price risk in India.

[12] There is anecdotal evidence that goods sold in ration shops are sometimes of poor quality, and occasional long queuing times to buy the goods - see eg Rao (2000).

with very different entitlements for the poor and non-poor. Overall, Indian states seem unable to effectively target transfers to poor households, in line with micro-evidence in Niehaus *et al.* (2013) for Karnataka. Limited targeting capacity is a concern for redistribution policies in all developing countries more generally: the World Bank estimates that the targeting of social safety nets is only marginally pro-poor in those countries (World Bank, 2014). I assume no government targeting capacity and perfect substitution between goods sold in the ration shops and in the market (no ordeals) in the baseline model below.

A final question of interest is the extent to which households arbitrage: the difference between the ration and market prices generates an incentive to re-sell quotas on the market. This question affects how we think about ration shop systems as a redistribution instrument: in a situation with costless re-sale the ration shop system essentially transfers the same amount to all households and is equivalent to a lump-sum transfer (Besley and Kanbur, 1988). There is no data available on re-sale of quotas but information on how much households consume from the ration shops enables me to assess the scale of arbitrage indirectly: if re-sale were costless we would see that all households would choose to purchase their total quota amount in order to re-sell the amounts they are not consuming on the market. Appendix Figure A1 presents the density distribution of household consumption of goods from the ration shops and quota levels. Many households consume less than the quota level; comparing consumption with official quotas I find that the quota is marginal for 23% of households for rice, 11% for sugar and 33% for kerosene. The evidence suggests that resale, if it occurs, must be costly, as a non-negligible share of households choose not to re-sell (all of) their rations.

The next sections consider under what conditions introducing a ration shop system is welfare increasing; key characteristics of the Indian context are built into the model's key assumptions. Regarding policy instruments I assume perfect implementation of the ration shop system, no government targeting capacity, and no re-sale. I discuss the impact of relaxing these assumptions at the end of the model section. Regarding market characteristics I introduce varying market prices in section 3.4 and home production in section 3.5.

3 Model

This section uses a tax reform approach to ask whether ration shop systems increase welfare compared to a world in which the government uses only linear commodity taxes. This allows me to characterize under what conditions (for what kind of household and government preferences) introducing a ration shop system is welfare increasing, and this for any quota level. The calibration exercise in the next section then considers whether the welfare effect is positive for the range of quota levels observed today in India's ration shop system. I start with a world with no price risk and home production. Details of all calculations can be found in the paper's theory appendix.

3.1 Set-up

There is a continuum of mass 1 of households i that differ in their income y_i and preferences characterized by utility function $u_i(.)$. There are K consumption goods x^k, with exogenous producer prices z^k and one numeraire good whose price is normalized to 1. Household i's preferences for good k are characterized by ϵ_{ik}, the uncompensated price elasticity of demand and η_{ik}, the income elasticity of demand. I write $v_i(.)$ household i's indirect utility function and s_i^k the budget share she spends on good k. I write p^k the consumer price of good x^k; households maximize utility subject to a standard budget constraint $\sum_k x_i^k p^k \leq y_i$.

In this section I simplify the analysis by assuming that only one good k is taxed and therefore drop all superscripts k - this assumption is relaxed in the appendix. I consider whether introducing a ration shop system for this good is welfare-improving compared to setting an optimal linear rate t such that $p = z + t$. I define a ration shop system by a set t_1, q, t_2 such that the consumer price of the good is given by:

$$p = \begin{cases} z + t_1 & \text{if } x_i \leq q, \\ z + t_2 & \text{if } x_i > q. \end{cases}$$

where $t_2 > t_1$, q is strictly bounded by the minimum and maximum values of consumption of the good and equilibrium consumption x_i is given by:

$$x_i = \begin{cases} x_i(z + t_1, y_i) & \text{if } x_i(z + t_1) \leq q, \\ x_i(z + t_2, y_i + (t_2 - t_1)q) & \text{if } x_i(z + t_2, y_i + (t_2 - t_1)q) \geq q, \\ q & \text{if } x_i(z + t_2, y_i + (t_2 - t_1)q) < q \text{ and } x_i(z + t_1) > q. \end{cases}$$

The distributions of households' incomes and preferences yield a distribution of consumption with density $h(x)$ and cumulative density function $H(x)$.[13] I consider two types of government preferences in turn: first a revenue-maximizing government then a welfare-maximizing one.

3.2 Revenue-maximizing government

Consider a government whose objective is to maximize total tax revenues $t\int_i x_i di$. If it can only use linear commodity taxes the optimal linear tax rate on a commodity is given by:

$$\frac{t^M}{z + t^M} = \frac{1}{-\epsilon} \tag{1}$$

where ϵ is the weighted average uncompensated elasticity of demand: $\epsilon = \frac{\int_i \epsilon_i x_i di}{\int_i x_i di}$. I assume throughout that uncompensated elasticities are negative for all goods so $t^M > 0$.

There are two ways to think about the effect of introducing a ration shop system: as a small decrease in t^M on consumption below q or a small increase in t^M on consumption above q. The

[13] For small values of $t_2 - t_1$ and q one can show that $x(z+t_1, y_i) > x(z+t_2, y_i + (t_2 - t_1)q)$ because the compensated price elasticity of the good is negative. This rules out the case $x(z + t_1, y_i) < q$ and $x(z + t_2, y_i + (t_2 - t_1)q) > q$.

impact on tax revenues dR_2 of introducing a small increase dt_2 in t^M above q is:

$$dR_2 = (1 - H(q))[x_2(q) - q + \frac{t^M}{z + t^M}(\epsilon_2(q)x_2(q) + \eta_2(q)s_2(q)q)]$$

where the subscript 2 indicates averages over households consuming at least the quota level q. The impact on tax revenues dR_1 of introducing a small decrease dt_1 in t^M below q can similarly be written:

$$dR_1 = -x_1(q)H(q) - q(1 - H(q)) + \frac{t^M}{z + t^M}[-\epsilon_1(q)x_1(q)H(q) + \eta_2(q)s_2q(q)(1 - H(q))]$$

where the subscript 1 indicates that averages are taken over households consuming less than the quota level q.

Replacing for $\frac{t^M}{z+t^M}$ using (1) we see that $dR_2 = dR_1$.

Proposition 1 *The total impact of introducing a ration shop system at quota level q on tax revenues scaled by the amount of revenues collected, $dR(q)$, can be written as:*

$$dR(q) = [\epsilon_2(q) - \epsilon + \frac{\epsilon_2(q) + s_2(q)\eta_2(q)}{\theta(q) - 1}]\frac{t}{z + t} \quad (2)$$

where t is the linear commodity tax rate and $\theta(q) = \frac{x_2(q)}{q} > 1$ is a scale parameter measuring the thickness of the right-hand side of the distribution of consumption of the good. The revenue effect is of opposite sign to the linear rate unless households consuming high amounts of the good have a very low price elasticity of demand compared to the average ($\epsilon_2 > \frac{\eta_2 s_2 + (\theta-1)\epsilon}{\theta}$). In particular if demand elasticities are homogeneous in the population ($\epsilon_2 = \epsilon$) and the government is maximizing revenues ($t = t^M > 0$) the revenue effect of introducing a ration shop system is negative, increasing in absolute value with the compensated elasticity of demand and decreasing in absolute value with the thickness of the right-hand side of the distribution of consumption.

A revenue-maximizing government will not find it optimal to use a ration shop system unless the price elasticity of demand is strongly decreasing with consumption. Intuitively a revenue-maximizing government would prefer to set a lower price to high-demand consumers to induce them to purchase more unless their purchases are substantially less price-elastic than the average. I assume such a price schedule (piece-wise decreasing taxes) cannot be implemented so a revenue-maximizing government will choose to levy a linear rate instead. The intuition behind this result is similar to that behind the Maskin-Riley quantity-discount result for profit-maximizing monopolist (Maskin and Riley, 1984); here a revenue-maximizing government has the same objective function as a monopolist and wants to minimize the efficiency cost (loss in consumption) generated by the tax system. In practice we have little information on the heterogeneity of demand parameters amongst the population so I assume in what follows that demand parameters η and ϵ are homogeneous and discuss the robustness of results with respect to this assumption in the calibration section below.[14]

The revenue impact of introducing a ration shop system increases in absolute value with the compensated elasticity of demand of households consuming at least q ($\epsilon_2(q) + s_2(q)\eta_2(q)$) which captures the strength of the behavioral response to the introduction of a RSS. This is the relevant parameter because the introduction of a RSS is equivalent for these households to an increase in the marginal price of the good of dt_2 compensated for by an increase in (virtual) income of $dt_2 q$.[15] An increase in the thickness of the right-hand side of the distribution of x ($\theta(q)$) lowers the magnitude of the revenue impact. Intuitively this is because the revenue gain from increasing the tax above q is increasing in the average consumption above q whereas the behavioral response is a function of q. Similarly the revenue cost of a decrease in t below q - a subsidy on the left-hand side of the distribution of x - is smaller, all else equal, for higher values of $\theta(q)$.[16]

3.3 Welfare-maximizing government

Consider now a welfare maximizing government whose preferences are characterized by the social welfare function $G(.)$, increasing and concave, and μ, the marginal value it places on one unit of public revenues. It maximizes

$$W = \int_i G(v_i(x))di + \mu t \int_i x_i di$$

Following Saez and Stantcheva (2016) I write household i's marginal social welfare weight - the value the government places on one extra unit of income to household i - as g_i.[17] I assume in what follows the government only cares about whether a household is poor or non-poor and define g_p (g_{np}) the social value of one extra unit of income to a poor (non-poor) household, with $g_p > g_{np}$. I write π the share of poor households in the population and $g = \pi g_p + (1-\pi)g_{np}$ the average marginal social welfare weight. This 'poverty-adverse' social welfare function is well suited to developing countries in which government objectives are often defined in terms of poverty minimization. Empirically they have the advantage of not requiring the full distribution of incomes to be known in contexts in which income is often measured with substantial measurement (Deaton, 1997). The drawback is sensitivity of the results to the definition of the poverty line; I pay particular attention to this problem in the calibration below. A particular case of interest is the one in which the government's alternative use of funds is a universal (non-distortive) transfer so that $\mu = g$. This case abstracts from exogenous reasons the government could have to value public revenues, I often refer to it below.

[14] Some evidence regarding the distribution of price elasticities of demand in a developing country setting is found in Attanasio *et al.* (2013).They find that price elasticities for food in Mexico are lower amongst poorer households.

[15] I follow the literature on non-linear income taxation by defining virtual income as the income that the household would receive if it could stay on the virtual linearized budget.

[16] This result is very close to that in Saez (2001) who shows that the top marginal income tax rate is increasing in the thickness of the right-hand-tail of the income distribution because the thicker the tail the more revenues the top marginal rate raises.

[17] Formally here $g_i = \frac{\partial G}{\partial v_i}\frac{\partial v_i}{\partial y_i}$.

The optimal linear rate is now given by:

$$\frac{t}{z+t} = \frac{(\mu - g) + (g_p - g_{np})\pi(1-\alpha)}{-\mu\epsilon} \tag{3}$$

where $\alpha = \frac{\int_{i \in P} x_i di}{\pi \int_i x_i di}$ represents poor households' share in total consumption. Equation (3) is Diamond (1975)'s many-person Ramsey rule for a poverty-adverse government. The linear rate is increasing in the government's revenue-preference $(\mu - g)$ for intuitive reasons. Setting $\mu = g$ we see that the optimal linear rate will be positive for goods consumed less by the poor on average $(\alpha < 1)$, increasing in absolute value with the strength of the government's preference for redistribution $(g_p - g_{np})$ and decreasing in absolute value with the average price elasticity of demand.

The impact of introducing a ration shop system can still be studied by increasing the tax above a quota q or decreasing the tax below q.

Proposition 2 *The welfare impact of introducing a ration shop system at quota level q, $dW(q)$, can be written as:*

$$dW(q) = -(\mu - g)\frac{\phi(q)}{\theta(q)-1} + (g_p - g_{np})[\pi\alpha - \pi_2(q)\alpha_2(q) - \pi_2(q)\frac{\alpha_2(q)-1}{\theta(q)-1} - (1-\alpha)\frac{\phi(q)}{\theta(q)-1}\pi] \tag{4}$$

where $\phi(q) = \frac{\epsilon_2(q)+\eta_2(q)s_2(q)}{\epsilon} > 0$ captures the strength of the behavioral response to taxation, $\pi_2(q)$ is the share of poor households amongst households consuming at least q and $\alpha_2(q) = \frac{\int_{x_i \geq q, i \in P} x_i di}{\pi_2 \int_{x_i \geq q} x_i di}$ the ratio of average poor consumption to average consumption amongst households consuming more than q.[18]

Consider first the role of $\phi(q)$. This term captures the strength of the behavioral effect of introducing a ration shop system, discussed above, relative to that of the linear tax. It has a negative effect on the total welfare impact if the optimal linear rate is positive, a positive effect otherwise. Intuitively distorting the consumption of households with the highest demand for the good away from the first best in which consumer prices are equal to producer prices is inefficient. When the optimal linear rate is positive a ration shop system is inefficient because it increases the wedge between consumer and producer prices for these households, when the optimal rate is negative it decreases this wedge and hence increases the efficiency of the tax system. This also explain why the more the government values public revenues (the higher $\mu - g$) the lower the welfare effect of the RSS: because a government that values public revenues more will set a higher optimal linear rate.

The welfare effect of the RSS is increasing in the share of poor consumption in total consumption (α), and this for two reasons. First, higher poor (relative) consumption, all else equal, increases the welfare effect of subsidizing low levels of consumption as long as $g_p > g_{np}$. Second, goods with a higher α have a lower optimal linear tax rate, and hence a smaller revenue cost (higher revenue gain if $\alpha > 1$). The parameters $\alpha_2(q)$ and $\pi_2(q)$ capture the extent to which the higher tax rate on

[18] All consumption amounts are equilibrium values when the market price of the good is equal to $z + t$.

high consumption levels works as a tax on the non-poor: the lower $\alpha_2(q)$ and $\pi_2(q)$, conditional on α, the better the increase in taxes is targeted to non-poor households.

Setting $\mu = g$ we see that the welfare effect of introducing a ration shop system is unlikely to be positive for two types of goods. The first are luxury goods - goods that are hardly ever consumed by the poor: the welfare effect is negative for small values of α even when no poor household consumes more than the quota level. Intuitively the redistributive potential of a luxury good is maximized when the government uses a linear tax rate because for this good the linear rate already acts as a proxy for a tax on the non-poor, it cannot be improved by introducing an piecewise increasing tax schedule. The second are inferior goods - goods that poor households always consume more than non-poor households. For these goods $\alpha_2(q) > 1$ and $\pi\alpha < \pi_2(q)\alpha_2(q)$ for all potential quota levels q so the total welfare effect will be negative unless behavioral responses are extremely large. The redistributive potential of taxing inferior goods is also maximized with linear rates: if poor households consume more of the good increasing the tax rate on high consumption amounts hurts the poor more than the non-poor.The only rationale for introducing a ration shop system for inferior goods is thus an efficiency one - lowering the subsidy on high consumption amounts - and this efficiency gain will only outweigh the redistributive cost for very large behavioral responses.

Overall expression (4) implies that the welfare effect of introducing a ration shop system at a given quota level will be maximized for necessity goods: goods that many poor households consume but few consume high amounts of (high α, low α_2 and π_2). Introducing a RSS for these goods allows the government to transfer income to poor households whilst still taxing the non-poor or (equivalently) to tax the non-poor without taxing the poor. Additionally, if the good is consumed more by the non-poor, the welfare effect will be higher the thicker the right-hand side of the distribution and the lower the compensated elasticity of demand of households with high demand relative to the average price elasticity. Finally note that the welfare effect can be positive for goods that poor household consume more than the non-poor on average ($\alpha > 1$) as long as the non-poor are still more likely to consume high amounts($\alpha_2(q) < \alpha$): goods that only a few non-poor consume but in high amounts and that most poor households consume in low amounts are also potential candidates for inclusion in ration shop systems.

3.4 Ration shop systems as insurance against price risk

Consider now a world in which the price of the good z varies at the local level.[19] Each household faces the same probability distribution of z, symmetric around a mean $\bar{z}$ with minimum z_{min} and coefficient of variation σ. Households' risk preferences are characterized by their relative risk aversion coefficient r_i. I assume for now that the prices of all other goods are held constant (this assumption is relaxed in the appendix). A ration shop system now sets the price of the good equal to a fixed price $\tilde{z} \leq z_{min}$ below a quota level q. This is equivalent to introducing both a fixed decrease in the tax rate $dt_1 = \bar{z} - \tilde{z}$ and a 'price stabilizing transfer' $z - \bar{z}$, positive or negative depending on the value of z faced by the household.

[19]I assume away aggregate risk so there's no need for insurance at the government level.

The welfare effect of price-indexed transfers is governed by the impact of prices on the marginal utility of income v_{yi}:

$$\frac{\partial v_{yi}(y_i, z)}{\partial z} = \frac{v_{yi}(y_i, z)}{z+t} s_i(z)[r - \eta] \tag{5}$$

This equation implies that price-indexed transfers of mean zero will increase households' indirect utility as long as their relative risk aversion is sufficiently high relative to their income effect. I assume throughout that $r > \eta$ so that there are gains from social insurance - as long as $r \geq 1$ a sufficient condition for this inequality to hold is that the good is not a luxury good (none of the goods considered in the calibration below are).

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:

$$E(v_i(y_i, z + t + dt)) = E(v_i(y_i, z + t)) - v_{iy} x_i (1 + \epsilon s_i (r - \eta)\sigma^2) dt \tag{6}$$

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 $g_i x_i (1 + \epsilon s_i (r - \eta)\sigma_z^2) dt < g_i x_i dt$.[20] The welfare cost of taxation is decreasing in the level of price risk σ so optimal linear taxes will be increasing in price risk. This is because consumption taxes tax households less in states of the world in which the price is high (because they consume less in those states) and their marginal utility of income higher (by assumption that (5) is positive), thereby providing them with insurance.[21] This insurance gain is higher for households that spend a larger share of their income on the good because they are more exposed to the risk. Introducing a non-linear tax (without a price stabilization component) in a world with price risk therefore has a higher behavioral cost than in a world without price risk because the optimal linear rate is higher as well as a positive (negative) insurance effect on households consuming more (less) than q.

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 can be written as:

$$E(v_i(y_i + q(z - \bar{z}), z + t)) = E(v_i(y_i, z + t)) + v_{yi} q s_i (r - \eta)(\bar{z} + t)\sigma^2 \tag{7}$$

The marginal social welfare effect of transferring $(z - \bar{z})q$ to household i consuming at least q is thus given by $g_i q s_i (r - \eta)(\bar{z} + t)\sigma^2 > 0$. The transfer has mean zero but a positive welfare effect because it provides the household with partial insurance against price risk.

Finally households consuming less than q are faced with a fixed price $\bar{z}$. This has the following impact on their utility:

[20] Here g_i is defined as the social value of giving household i an extra unit of income when the price is equal to $\bar{z}$: $g_i = \frac{\partial G_i}{\partial v_i} v_{iy}(\bar{z})$.I assume that parameters ϵ and η do not vary with z.

[21] This intuition behind this result is similar to that for Varian (1980)'s result regarding the social insurance role of income taxation when income is stochastic.

$$E(v_i(y_i, \bar{z}+t)) = E(v_i(y_i, z+t)) + v_{iy}(s_i(r-\eta)+\epsilon)x_i(\bar{z}+t)\sigma^2 \quad (8)$$

The marginal social welfare effect of stabilizing the price for household i, $g_i(s_i(r-\eta)+\epsilon)x_i(\bar{z}+t)\sigma^2$, is positive if $s_i(r-\eta)+\epsilon > 0$. This result, first derived in Turnovsky *et al.* (1980), states that households value price stabilization if their relative risk aversion is high relative to their price and income elasticities of demand (in absolute value). Intuitively when the relative price of a good increases households can diversify their consumption to other goods (an indirect utility gain) but find that their income enables them to buy less of the good (an indirect utility cost). Households with lower absolute value price and income elasticities will substitute their consumption away from the good less when its price increases and thus experience a bigger loss. Note that this transfer does not have a mean of zero: households receive a positive transfer when their consumption is low and a negative one when their consumption is high, these transfers are a share of their consumption so the total effect on government revenues is positive and given by $-\epsilon x_i(\bar{z}+t)\sigma^2$. The total welfare effect of stabilizing the price of the good for household i consuming less than q is therefore $[g_i s_i(r-\eta) - \epsilon(\mu - g_i)]x_i(\bar{z}+t)\sigma^2$.

Adding these effects across all households we get the following proposition.

Proposition 3 *The welfare effect of introducing a ration shop system at quota level q in a world in which the price of the good varies, $dW^P(q)$, is equal to the welfare effect in a world without price risk (4) plus an insurance effect:*

$$\begin{aligned} dW^P(q) = dW(q) + \sigma^2\{&-\epsilon(r-\eta)[\frac{\int_{x_i\geq q} g_i s_i x_i}{x_2(q)(1-H(q))}\frac{\theta(q)}{\theta(q)-1} - \frac{\int g_i s_i x_i}{x}(1+\frac{\phi(q)}{\theta(q)-1})] \\ &+ (r-\eta)(\bar{z}+t)[\frac{\int_{x_i<q} g_i s_i x_i}{x_1(q)H(q)}\frac{\theta(q)}{\theta(q)-1} + \frac{\int_{x_i\geq q} g_i s_i q}{(x_2(q)-q)(1-H(q))}] - \epsilon(\bar{z}+t)\frac{\int_{x_i<q}(\mu-g_i)s_i x_i}{x_1(q)H(q)}\frac{\gamma(q)}{\theta(q)-1}\} \end{aligned} \quad (9)$$

where $\gamma(q) = \frac{\int_{x_i<q} x_i di}{\int_{x_i\geq q} q di}$. The first line represents the effect of introducing a piecewise increasing tax without a price stabilization component, the second line is the effect of the price stabilization component.

The insurance effect of introducing a piecewise increasing tax (first line of (9)) can be positive or negative and is increasing in both the share of poor households amongst those consuming more than q and their budget share. This is because increasing the tax above q has a positive insurance effect on households consuming more than q. The price stabilization effect (second line of (9)) is positive except when ϵ is very large. Note however that the effect of the non-linear tax is scaled by ϵ, that of price stabilization by the amounts the households spend on the good $x_i(\bar{z}+t)$; the total insurance effect will therefore be positive for most likely values of the parameters. Intuitively, in a world with risk-averse households and a risk-neutral government a government transfer that diminishes the amount of risk households are exposed to will have a positive welfare effect unless households are extremely responsive to changes in prices - in which case they value the insurance less and the efficiency cost (price distortion) of price stabilization dominates. When positive the total insurance effect is increasing in the level of price risk σ and the budget share of the good, particularly amongst the poor.

3.5 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.[22] This endowment can be consumed or sold on the market at price z. 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 (4). 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. The impact of prices on the marginal utility of income v_{yi} is now given by:

$$\frac{dv_{yi}(y_i(z), z)}{dz} = \frac{v_{yi}(y_i(z), z)}{z+t}[s_i(z)(r-\eta) - rs_{\omega i}(z)] \tag{10}$$

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.

Proposition 4 *The welfare effect of introducing a ration shop system at quota level q in a world with price risk and in which households have endowments of the good, $dW^H(q)$, is equal to the welfare effect without endowments (expression (9)) plus an extra term:*

$$\begin{aligned} dW^H(q) =& dW^P(q) + \sigma^2\{+\epsilon r(\frac{\int_{x_i \geq q} g_i s_{\omega i} x_i}{x_2(q)(1-H(q))}\frac{\theta(q)}{\theta(q)-1} + \frac{\int g_i s_{i\omega} x_i}{x}(1+\frac{\phi(q)}{\theta(q)-1})) \\ & - r(\bar{z}+t)(\frac{\int_{x_i<q} g_i s_{\omega i} x_i}{x_1(q)H(q)}\frac{\theta(q)}{\theta(q)-1} + \frac{\int_{x_i \geq q} g_i s_{\omega i} q}{(x_2(q)-q)(1-H(q))}) + \epsilon(\bar{z}+t)\frac{\int_{x_i<q}(\mu - g_i)s_{\omega i}x_i}{x_1(q)H(q)}\frac{\gamma(q)}{\theta(q)-1}\} \end{aligned} \tag{11}$$

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 (9) tends to be positive. Intuitively the endowments

[22] The assumption of fixed endowments is motivated by data constraints in the calibration exercise: no estimates of the effect of prices on home production are available. I discuss its implications (no efficiency cost of providing insurance) below.

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.

3.6 Extensions

Two of the model's assumptions can be relaxed in a simple way to more closely resemble the context of developing countries. First, the assumption that the government has no capacity to identify household's poverty status is extreme: in practice most developing countries are able to exclude some non-poor households from the list of eligible households. In the appendix I introduce imperfect targeting in the model by assuming that the government's alternative use of funds is a transfer that reaches poor households with probability $\hat{\pi}$ and non-poor households with probability $1-\hat{\pi}$. Imperfect targeting is captured by the assumption $1 > \hat{\pi} > \pi$ and the marginal value of public funds is now $\mu = \hat{\pi} g_p + (1-\hat{\pi}) g_{np} > g$. Comparing this to a setting in which the government has no targeting capacity and the marginal value of public funds is simply g, I show that the total welfare effect of introducing a RSS is decreasing in the government's targeting capacity $\hat{\pi} - \pi$: the redistribution gain from ration shops are more likely to be negative if the government has access to another redistributive instrument. If the government can perfectly target poor households ($\hat{\pi} = 1$, as is arguably the case in rich countries) the redistribution effect of introducing ration shops is always negative.

Second, I relax the assumption of no administrative or corruption costs of introducing ration shops. I assume instead that for each unit transferred to households through the RSS the government must spend $(1+\beta)$ units where $\beta > 0$ is the leakage rate. This decreases the welfare effect of introducing ration shops by $\mu\beta\frac{\gamma(q)+1}{\theta-1}$: the negative impact of leakages increases with the value the government places on public revenues μ and the relative cost of subsidizing low levels of consumption $\gamma(q)$, and decreases with the revenue potential of taxing higher levels of consumption $\theta(q)$. I consider the impact of relaxing both the no-corruption and the no-targeting capacity assumptions in the calibration results for India below.

The paper's appendix finally discusses the impact of relaxing the model's convenience assumptions. I first allow for the taxation of several goods at the same time. This affects the revenue (behavioral) effect of introducing a RSS insofar as changes in the tax levied on one good affect the taxes collected on all other goods. This extra revenue effect cannot be signed a priori as it is a function of cross-price demand elasticities. These are no estimates of these elasticities available for the Indian context but they are likely much smaller than the own-price elasticities so this extra effect would be orders of magnitude smaller than the revenue effect generated by own-price elasticities. I also allow for the prices of several goods to vary at the same time. This affects the insurance effect of the ration shop system: intuitively if households spend the same budget share on two goods and the prices of these two goods are perfectly negatively correlated the price risk for these two goods cancel out and there is no need for social insurance; if on the other hand they are perfectly positively correlated insurance against variations in the price of one of the goods is more valuable the more the household consumes the other good. The overall insurance effect of introducing a RSS for one good when the price of all goods co-vary is therefore increasing in the correlation between the price of this good and the price of all other goods. Appendix Table A2 shows that the prices of the goods considered in the calibration are on average positively correlated with each other, as we would expect if supply shocks affected the production of all goods in a similar way. This suggests that focusing on price risk for one commodity at a time, as I do in the calibration, under-estimates the total insurance effect of introducing ration shops. Again, this effect is likely second order because correlations are small.

4 Data and method

This section details the data and method used to estimate the welfare effect of introducing ration shops in India (calibration of expressions (4), (9) and (11)).

4.1 Data

I use the 68th round of the nationally representative annual consumption survey carried out by the Indian National Sample Survey Organisation (NSSO). The survey contains detailed information on all goods consumed over the last month by 120,000 households in 2011-2012 within the twenty largest states of India. It is stratified by urban and rural areas of each district and by quarter of the year in order to be representative at that level and I use the household level sampling weights provided by the NSSO. I consider eight good categories of interest: rice, wheat, sugar, kerosene, coarse cereals, pulses, cooking gas and 'meat and fish products'.[23] The first four goods are sold in ration shops in most states and so are coarse cereals in some Eastern states. I also consider pulses and 'meat and fish products' because they are consumed by most households and represent a non-negligible share of the typical household's budget, making them potential candidates for inclusion in the RSS: 62% of households consumed meat and fish products in the last month, 98% consumed pulses.[24] Cooking gas (known as LPG in India) is of intrinsic interest as the main commercial source of energy used by households besides kerosene. Moreover, the Indian government has long subsidized cooking gas with linear subsidy but in 2013 set a household quota on the amounts subsidized, effectively introducing a RSS for cooking gas with very high quota levels (IISD, 2014). Including cooking gas in the calibration allows for an evaluation of the welfare effect of this policy change.

Importantly for the purpose of this paper the survey asks households to report for each good i) their purchases from the ration shops ii) their market purchases iii) their consumption from home

[23] Coarse cereals include jowar and small millets, staple foods in many parts of East India. The list of items included in each good category can be found in the online Appendix.

[24] Pulses have been introduced in ration shops in two states (Punjab and Chhattisgarh) since 2012.

production. This enables me to estimate households' counterfactual consumption in the absence of taxes and ration shops and measure the endowment shares of income for each good (see below). Households also report both the quantity and the value of the goods purchased, I use unit values (ratios of values to quantities) as proxies for the price of the good when sold on the market and when sold through the ration shops.

This survey is typical of consumption surveys that are routinely done in developing countries, though considered to be of high quality it has some limitations (see Deaton, 1997, for a detailed description of the survey). In particular it does not attempt to directly measure income. I use total consumption expenditures as a proxy for income following the methodology used by the NSSO itself, and apply the state-level official poverty lines to categorize households as poor or non-poor - the share of poor households (π in the model) in the population is 22.2%. These poverty line levels are computed on the basis of estimates of households' total expenditures obtained using the NSSO surveys and are designed to be applied to this total expenditures variable and not households' incomes.[25]

4.2 Household and government preference parameters

Demand elasticity estimates for India are scarce, evidence of how they differ across household groups inexistent; I assume for simplicity that price and income elasticities are homogeneous across households. I use estimates of price and income elasticities for the food commodities from Kumar *et al.* (2011) and from Gundimeda and Khlin (2006) for kerosene. As robustness checks I set all demand parameters equal for all goods and consider alternative estimates of the price elasticity for food commodities found by Deaton and Subramanian (1994).[26] I use a relative risk aversion coefficient value of 3 as a baseline, in line with experimental estimates found by Carlsson *et al.* (2003) amongst Indian subjects, and also consider results for alternative values and different risk aversion levels for poor and non-poor households. Baseline results assume the government values an extra unit of income to the poor twice as much as that to the non-poor ($g_p = 2$ and $g_{np} = 1$) and set the marginal value of public funds (μ) equal to the average welfare weight g. I also consider results for alternative poverty lines and allowing for limited targeting capacity, as I explain below.

4.3 Counterfactual distributions of consumption

Expressions (4), (9) and (11) cannot be directly calibrated using the distributions of consumption in the survey because observed consumption amounts are affected by existing taxes and subsidies. I simulate hypothetical consumption for alternative tax schedules by taking linear approximations

[25] This method likely underestimates the income of the richest households, which tend to be under-represented in consumption surveys anyways. The numerical analysis is therefore unable to consider the extent to which a RSS can tax the richest households, a relatively untapped source of government revenues in India (Piketty and Qian, 2009).This limitation of the data mirrors a limitation of commodity taxation in practice: progressive taxation of the very rich is unlikely to be achieved through commodity taxes.

[26] Both Kumar *et al.* (2011) and Gundimeda and Khlin (2006) use the NSSO consumption survey and use the same commodity classification as I do. Deaton and Subramanian (1994) uses a smaller sample of households in Maharashtra.

around the existing tax schedules, using the demand elasticities described above and the consumption taxes, RSS quotas and prices in place in India in 2011-2012. I use the commodity-level VAT rates levied by each state for the consumption taxes. As explained above the ration prices and quotas are not uniformly defined across households but vary depending on household characteristics (possession of poverty cards, location and demographic characteristics) not observed in the survey. I therefore use the ration price and consumption from ration shops declared by households to proxy for the parameters of the RSS that they face.[27]

4.4 Price risk

To proxy for the price risk that a typical Indian household faces I consider within-market variations in unit values over time using the NSSO consumption surveys for the years 2002-2003 to 2011-2012 to capture time variations. I define a market as the lowest geographical unit at which the NSSO surveys are representative in all years - the rural and urban parts of each of the 77 NSS regions (which I call sub-regions), defined as areas within a state with similar agro-climatic conditions.[28] I use within sub-regions across quarters variation in mean unit values (deflated using an all-India commodity specific deflator) to proxy for the coefficient of variation σ for each good. 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 (for example I use the price variation of the item 'chicken' for the good 'meat and fish' in most sub-regions). Baseline results assume all households face the same level of price risk but poorer households may face different levels of price risk from non-poor households (poorer households are more likely to be in remote rural areas) so I also measure price variations over time for poor and non-poor households separately and discuss results obtained allowing for these different levels of price risk.

There are several known shortcomings of using unit values as a proxy for prices: variations in unit values may reflect measurement error, quality effects, or non-linear (market) price schedules (see for example Deaton and Tarozzi, 2005). This could lead me to over-estimate the level of price risk faced by households. I compare unit values from the survey to an alternative measure of price from the rural price collection survey undertaken by the NSSO at the village level to compute a nationally-representative rural consumer price index and find remarkably similar distributions in both datasets (including very similar coefficients of variation - see appendix section 2.3 for more details). This dataset is only available for rural areas so cannot be used in the calibration but the

[27] In line with the model's assumptions I assume full incidence of taxes on consumers. Unit values as a proxy for market prices are not available for households that do not purchase the goods outside the RSS, I use median within district market prices to proxy for the price that these households would face should they choose to buy on the market.

[28] 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 to define a market under-estimates the level of price risk faced by households if supply shocks are not perfectly correlated across villages. Some of the rounds of NSSO surveys used for the years 2002-2003 to 2010-2011 are 'thin' rounds, only representative at the NSS sub-region level, the year 2011-2012 is a 'thick' round representative at a sub-district level.

comparison suggests unit values are a reliable proxy for prices.

4.5 Home production

The survey reports households' consumption of each good from their home production but not how much they produce. 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 which 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[29] and estimate the relationship between land and consumption of each good from home production amongst these households. 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 (see the appendix for more details).

4.6 Calibration parameters

Table 3 presents the key characteristics determining the welfare effect of ration shop systems for each good. I first present characteristics of the distribution of consumption: the share of poor consumption in total consumption (α) and both the share of poor consumption in total consumption by households consuming at least q (α_2) and the share of poor households amongst these households (π_2) for quota levels equal to the 10th, 25th and 50th percentiles of the distribution of consumption.[30] We see that there are three types of goods. First, rice wheat and kerosene are necessity goods that poor households consume slightly less than poor households (α close to 1). As we consider consumption above potential quota levels we see that poor households are both less likely to consume more than a given level of the good ($\pi_2(q)$ is decreasing with q for rice and kerosene), and, when they do, consume lower amounts on average than the non-poor ($\alpha_2(q)$ also decreasing with q for all three goods). The share of poor consumption in total consumption is high and falls particularly fast as we consider higher potential quota levels for kerosene; this suggests kerosene may be a particularly good candidate for inclusion in a RSS from a redistribution perspective. Second, meat and fish products, pulses, sugar and cooking gas are traditional normal goods: they are consumed substantially more by the non-poor (α below two-thirds), and poor households are less likely than non-poor households to consume high amounts ($\pi_2(q) < \pi$, where $\pi = 0.22$). This is especially true for cooking gas. Note however that these goods are consumed in large quantities by some poor households: $\alpha_2(q)$ is increasing in q for all four goods. Finally coarse cereals are

[29] Households with no access to the RSS will choose to consume their home production prior to buying from the market as long as there is some cost of bringing their home production to the market.

[30] Consumption levels are counterfactual amounts obtained if the government levied the optimal tax rates defined in (3). Percentiles are defined over the distribution of consumption excluding null consumption.

consumed more by poor households than non-poor households on average, but the share of poor consumption in total consumption falls as we consider consumption above given quota levels. This is because coarse cereals are consumed by few non-poor households but in large amounts by those non-poor households that do consume the good. Price and income elasticities presented in Table 3 are low overall, except for meat & fish products and kerosene.

Turning to determinants of the insurance effect of a RSS we see that price risk is highest for the three cereals, as expected given the very local nature of markets for cereals in India. It is lowest for sugar, a commodity whose production is less influenced by local weather conditions. Budget shares are large for rice and to a lesser extent for cooking gas, meat and fish products and wheat. The good with the lowest budget share is kerosene. Finally, the income share of home production endowments is negligible for all goods except the three cereal types. These shares are orders of magnitude lower than budget shares, particularly amongst the poor.

5 Welfare impact of ration shops in India

Table 4 presents baseline results. Typical quota levels in India today are located between the 10th and 50th consumption percentiles of consumption for all goods so I focus on welfare effects obtained for quota levels at the 10th, 25th and 50th percentiles of the distribution of consumption.[31] The first three columns report the effect of introducing a ration shop system in a world without price risk - expression (4) above. Recall that in this world the effect can only be positive if it enables the government to redistribute from the non-poor to the poor or (if the good is consumed more by the poor on average) if it lowers the tax distortion on households with higher demand for the good. We see that the effect is positive for all quota levels considered for rice, kerosene and coarse cereals - the three goods consumed relatively more by the poor on average. It is negative or very small for the four goods with the lowest poor consumption share - pulses, sugar, meat & fish products and particularly cooking gas which has a very small poor consumption share. And finally it is positive for lower quota levels for wheat, which has an intermediate poor consumption share. Note that the effect is particularly large for kerosene - it is at least three times the effect for rice at all quota levels. This is because the share of poor consumption in the total above a given consumption level declines steeply for kerosene as we move up the distribution of consumption, as seen in Table 3.

The next three columns report the added effect on welfare of introducing a ration shop system in a world with price risk - the insurance effect in expression (9) above. This effect is positive and increasing with the quota level, as expected: as the quota level increases the ration shop system insures a larger share of consumption against price fluctuations. It is substantially larger for rice than for any other commodity because both the average budget shares and the level of price risk are high for rice. It is very low - at least four times smaller than for rice - for sugar and kerosene; sugar has both a low budget share and low price risk, kerosene has high price risk but a very low budget share. The insurance effects for meat & fish products and pulses is comparable to, or higher

[31] All welfare effects are multiplied by 10 to facilitate exposition.

than, that for coarse cereals despite lower levels of price risk; this is because these goods represent a higher share of the budget of households that consume them.

Finally the last three columns present the total effect in the presence of price risk - the sum of the effect without price risk and the insurance effect. We see that the total welfare effect is always positive for kerosene, rice and coarse cereals, but the source of these positive effects is different for these three goods. For kerosene the insurance effect is negligible but it represents 4-30% of the total effect for rice and 3-8% of the total effect for coarse cereals. Total effects are positive for wheat except at the high quota level at which the negative redistribution effect dominates. The welfare effect is negative for meat & fish, pulses and sugar except at low quota levels where the insurance effect compensates for the negative redistribution effect - though note that even at these low quota levels the total effect for these goods is at least five times smaller than that for wheat. Finally the total welfare effect of introducing cooking gas in a RSS is negative and of much bigger magnitude than that for all other goods at all possible quota levels. This is due to the very low share of poor households consuming non-negligible amounts of cooking gas and suggests that as long as we place a higher welfare weight on poor than on non-poor households the 2013 reform was welfare decreasing. I exclude cooking gas from graphical results in what follows for ease of exposition, no robustness check or alternative calibration specification ever leads to positive welfare gains for this good. Figure 3 explores the distribution of welfare effects for quota levels below median consumption levels in more detail.[32] The top graph considers how often ration shops have positive welfare effects if we randomly pick a quota level, the bottom graph presents the median value of the welfare effect over all quota levels. Both graphs paint a similar picture: welfare effects are always positive and large for rice, kerosene and coarse cereals; the welfare effect is positive for half the quota levels for wheat, and negative in the majority of cases for sugar, meat & fish products and pulses.

Turning to the effect of home production, appendix Table A3 presents results allowing for home production, using both methods detailed above to estimate home production endowments. Results are extremely similar when home production is introduced, as expected given the low home production endowment shares seen in Table 3. Allowing for home production only affects results for cereals, and marginally so - the total welfare effect of introducing a ration shop at a quota equal to the 25th percentile decreases by 1-6% for the three cereal types.

5.1 Robustness checks

Several parameters of the calibration are likely specified with error, I present robustness checks changing the value of these parameters in the appendix. First, there is uncertainty regarding the real values of the demand elasticities so I consider results obtained by setting the same elasticities for all goods. I bias against finding a positive welfare effect by setting income and price elasticities

[32] Results for higher quota levels are available upon request. They are more sensitive to changes in the right tail of the distributions and hence potential outliers, and of less policy interest as no government sets quotas above the median consumption level.

to their lowest level observed across all goods (-0.8 for the price elasticity and -0.1 for the income elasticity). Results are extremely similar to those obtained using baseline values: the only change of note is a clear decrease in the total welfare effect for meat & fish due to the fact that the baseline value of the income elasticity is high for this good (see appendix Table A4, first three columns). This robustness of results to changing the value of demand parameters suggests that letting demand parameters vary with consumption levels wouldn't affect the results in a meaningful way. Results are also qualitatively similar when I vary the value of relative risk aversion - the insurance effect increases in the value of the risk aversion coefficient, as expected, but the overall conclusion remains unchanged.

Second, measurement error could lead to some households reporting abnormally high consumption value. These observations could affect the calibration results through their impact on the right-hand tail of the distribution of consumption (parameters $\theta(q)$, $\alpha_2(q)$ and $\pi_2(q)$). Appendix Table A5 presents results obtained when excluding households consuming more than the 99th or 95th percentile of consumption for each good. The total welfare effect decreases a little for wheat (the good with the highest right-scale parameter at baseline, see Table 3) but 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.

Third, I consider alternative classifications of households as poor or non-poor in appendix Table A9. Robustness to the definition of the poverty line is of particular concern as measurement error means some households are likely wrongly classified so I present results obtained when increasing or decreasing the state-level poverty lines by 5, 10 or 20% (this varies the poverty headcount ratio from 10% to 36%). Welfare effects of introducing a RSS vary when the poverty line changes - they tend to increase as the poverty line increases - 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.

Fourth, note that some of the eight good categories considered (coarse cereals, meat & fish products and pulses) aggregate several different commodities. By aggregating all meat & fish products in one single good category I am implicitly assuming that one kilo of fish sold through the ration shop would be a perfect substitute for one kilo of mutton or chicken. To relax this strong assumption I calibrate the welfare effect of introducing a RSS for the commodities most commonly consumed in each category in appendix Table A10. Results obtained at the commodity level are similar to those obtained at the good level: welfare gains are always negative for arhar (the most common pulse) and chicken (the most common meat & fish product) and always positive for jowar (the most common coarse cereal), for which the welfare gains now exceed those for rice.

Finally I relax the assumption that poor and non-poor households are affected by price variations in the same way. Poor households are much closer to subsistence levels of consumption than non-poor households, this likely makes them substantially more risk averse (see Chetty and Looney, 2006). They tend to live in more remote areas so could also face higher levels of price risk. In appendix Table A6 I double the relative risk aversion coefficient of the poor and/or allow for different levels of price risk for poor and non-poor households.[33] Results are qualitatively unaffected though as expected welfare effects increase a little when the poor are assumed to be more risk averse. This is particularly true for rice and wheat - the goods with the highest budget shares - for which the welfare effect increases by 4-8% for quotas at the 25th consumption percentile. Overall these results suggest that the magnitude of the welfare effect of introducing a ration shop system is driven by the relative distributions of consumption for poor and non-poor households, not by the precise shape of the right-hand tail of these distributions, the precise definition of the poverty line used, or values of the demand parameters.

5.2 Results by regions

Two types of results for subsamples of the population are of interest. First, welfare effects of introducing a RSS could vary across states because both household preferences and poverty rates differ by state (see Atkin, 2013). From a policy perspective this variation is relevant as state governments have some discretion over which goods to sell in ration shops. Appendix Table A8 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.[34]

Second, rural and urban households have different home production endowments and may have different consumption patterns. The government could in theory distribute different goods through ration shops in urban and rural areas, indeed coverage of rural areas was much poorer until the mid 90s, when the opening of new ration shops in rural areas started to mitigate the 'urban bias' of the system (Himanshu, 2013). Figure 4 presents results separately for urban and rural households.[35] 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 are mostly due to the fact that a higher share of the population is urban in the wheat - or coarse cereals - consuming states of India; they reinforce the conclusion that different areas should include different cereals in the ration shops. Gains for kerosene are 25% larger in urban areas, reflecting the fact that kerosene is the main energy source for poor households in urban areas but not so in rural areas, where biofuels play a larger role (Khandker *et al.*, 2010).

[33] I decrease risk aversion of the non-poor to leave average risk aversion unchanged in the population. Coefficients of variation for the poor and non-poor are obtained using the method described above on sub-samples consisting only of poor or non-poor households.

[34] These goods are pulses in Gujarat and Madhya Pradesh, sugar in Karnataka, and meat & fish products in Uttar Pradesh and Gujarat.

[35] See appendix Table 4 for full results.

6 Discussion

Some of the model's assumptions regarding the policy instruments available to the government can be relaxed. As explained above the welfare effect of a RSS will decrease if we allow for some targeting capacity in the form of a transfer that reaches the poor with probability $\hat{\pi} > \pi$. I use estimates of $\hat{\pi}$ from Niehaus *et al.* (2013) who measure households' statutory poverty status (possession of a state-issued below poverty line card) and actual poverty status in rural Karnataka.[36] They find that the inclusion rate (probability that a household is poor conditional on it being statutorily poor) is only 14% higher than it would be under universal eligibility. Using this estimate of the government's targeting capacity I find a sharp decrease in the median welfare effect of the RSS for all goods, as expected, as well as in the share of positive effects below the median quota level for all goods except for kerosene (see Figure 5). Inspection of the results for different quota levels (see appendix Table A11) show that the welfare effect remains positive with targeting for low quota levels (10th percentile) for rice, wheat, coarse cereals and kerosene, but becomes negative at the 25th percentile for all goods except kerosene. Simulations show that a RSS for wheat, coarse cereals, rice or kerosene is no longer welfare-increasing at any quota level when the inclusion rate is, respectively, 23%, 31%, 34% and 38% higher than that under a universal transfer.

The assumption of no administrative or corruption costs of implementing a ration shop system can similarly be relaxed. High administrative costs of procurement, storage and transportation are oft-cited aspects of ration shop systems and in the Indian context corruption is also a concern (Khera, 2011b). We expect the welfare gains from introducing a RSS to unambiguously decrease when I assume that for each unit transferred to households through the system the government must spend $1 + \beta$ unit, where β measures the extra distribution cost (or leakages) of transfers going through the RSS relative to the government's alternative use of revenues - a universal transfer (see theory appendix). I present results for different values of β in appendix Table A12. I find that at a 3% leakage rate the welfare effect of a RSS is still positive (albeit only at low quota levels) for kerosene and the three cereal types but the positive welfare effects are wiped out for all goods for leakage rates above 6%.

The model also makes some assumptions regarding the supply side of the markets for these goods which cannot easily be relaxed but merit discussion. First, I assume throughout that producer prices are exogenous and hence unaffected by the introduction of a ration shop system. This assumption may be true for small quotas and non-linearities in the tax schedule, but is unlikely to hold for India's current RSS parameters. The effect of ration shops on prices can be signed however as long as long as income effects are small and introducing a RSS increases total supply of the good (through imports or higher-than-market prices offered to producers of the good by the government, as is the case in India): in this case we expect market prices to fall, in line with empirical evidence for Mexico in Cunha *et al.* (2017). This would favor net-consumers at the expense of net producers and could increase the overall efficiency of markets under imperfect competition, as shown by

[36] Formally I use results presented in Table 3 in Niehaus *et al.* (2013) to obtain a measure of the government's targeting capacity $\frac{\hat{\pi}}{\pi}$. Details can be found in the appendix.

Coate (1989). Second, assuming that households' home production of the goods is fixed rules out a potential efficiency cost of providing insurance against price risk (moral hazard): limiting households' exposure to price variations decreases their incentives to insure themselves by producing more at home or diversifying their home production. 85% of households report owning less than 0.2 hectares of land in the survey however, suggesting the scope for such moral hazard is limited in practice. Relaxing both these assumptions in the model would require specifying the market structure and the exact form of the government's intervention on the supply side of the markets, both of which vary greatly across countries which have ration shop systems.[37] Calibrating such a richer model would then require estimates of the effects of prices on home production and the general equilibrium effects of introducing a ration shop system on market prices, neither of which are available for India. I leave considerations regarding the effect of introducing ration shop systems on the supply side of markets to future research.

Finally note that the model above was designed with developing countries in mind but may help explain why developed countries still use some forms of 'universal but capped' subsidies on the consumption of some goods. Developed countries rely heavily on income taxes and transfers for redistribution but these have both efficiency and administrative costs. Piecewise increasing taxes on some commodities could therefore be part of the optimal tax mix if these commodities are necessities, subject to substantial price risk and/or represent a large share of households' incomes. The universal subsidies on health consumption up to a certain amount found in the UK's National Health Service are a good example of a 'ration shop system' in a rich country. Health services satisfy the model's conditions for a positive welfare impact of a RSS as they are a necessity good and, whilst not subject to substantial local price risk, demand for health services is negatively correlated with household-level income shocks so there could be insurance gains from a capped health subsidy.[38]

7 Conclusion

This paper shows that ration shop systems, a particular tax instrument found in developing countries, can be part of the optimal policy mix when we take into account the particular characteristics of these countries. Piecewise increasing commodity taxes play a redistributive role as soon as we no longer assume what standard public finance models typically take for granted, namely governments' capacity to observe households' incomes. I show that in this context introducing a ration shop schedule can be welfare-improving for many types of goods and will yield largest gains for necessities: normal goods that are consumed by poor households in non-negligible amounts. Taking into account a particular characteristic of markets in developing countries - local variations in commodity prices - introduces another potential motivation for introducing a ration shop system:

[37] In particular a RSS system which relies on food vouchers and hence does not increase local supply (such as the one in Sri Lanka) will have different supply-side effects from one in which the government buys goods in areas in which supply is high and then redistributes them, as is the case in India.

[38] France's quasi-universal and capped housing subsidy is another good example - see Fack (2006).

by stabilizing the price of goods up to a quota level ration shops provide households with (partial) insurance against price risk.

Calibration results for India suggest that ration shop systems are welfare-improving compared to linear commodity taxes for cereals and kerosene under a wide range of households and government demand parameters. India's 2013 National Food Security Act guaranteed access to cereals at a fixed subsidized price to the vast majority of Indian households, but the distribution of kerosene in the RSS is currently being debated. This paper's results suggest keeping kerosene in the ration shops may be one way for the government to provide transfers to the poor whilst still taxing non-poor households, at least until more efficient forms of redistribution are developed.

References

Ahmed, A., Quisumbing, A., Nasreen, M., Hoddinott, J. and Bryan, E. (2009). *Comparing food and cash transfers to the ultra-poor in Bangladesh*. Tech. rep., IFPRI Research Monograph.

Alatas, V., Banerjee, A., Hanna, R., Olken, B. A. and Tobias, J. (2012). Targeting the Poor: Evidence from a Field Experiment in Indonesia. *American Economic Review*, **102** (4), 1206–40.

Alderman, H. (2002). *Subsidies as a social safety net: effectiveness and challenges*. Social Protection Discussion Papers 25299, The World Bank.

Allen, T. and Atkin, D. (2016). *Volatility and the Gains from Trade*. NBER Working Papers 22276, National Bureau of Economic Research, Inc.

Atkin, D. (2013). Trade, Tastes, and Nutrition in India. *American Economic Review*, **103** (5), 1629–63.

— and Donaldson, D. (2015). *Who's Getting Globalized? The Size and Implications of Intranational Trade Costs*. NBER Working Papers 21439, National Bureau of Economic Research, Inc.

Atkinson, A. B. and Stiglitz, J. E. (1976). The design of tax structure: Direct versus indirect taxation. *Journal of Public Economics*, **6** (1-2), 55–75.

— and — (1980). *Lectures on Public Economics*. McGraw-Hill, New York.

Attanasio, O., Maro, V. D., Lechene, V. and Phillips, D. (2013). Welfare consequences of food prices increases: Evidence from rural mexico. *Journal of Development Economics*, **104** (Supplement C), 136 – 151.

Bachas, P. and Soto, M. (2017). *Not(ch) Your Average Tax System: Corporate Taxation Under Weak Enforcement*. Tech. rep., Mimeo, World Bank.

Balani, S. (2013). *Functioning of the Public Distribution System: An Analytical Report*. Tech. rep., PRS Legislative Research, New Delhi.

Banerjee, A., Hanna, R., Kyle, J., Olken, B. A. and Sumarto, S. (2016). *Tangible Information and Citizen Empowerment. Identification Cards and Food Subsidy Programs in Indonesia.* Tech. rep., mimeo, MIT.

—, —, —, — and — (2017). *Private Outsourcing and Competition: Subsidized Food Distribution in Indonesia*. Tech. rep., Mimeo MIT.

Besley, T. and Persson, T. (2013). Taxation and development. *Handbook of Public Economics*, **5**, 51 – 110, handbook of public economics, vol. 5.

Besley, T. J. and Kanbur, S. M. R. (1988). Food subsidies and poverty alleviation. *Economic Journal*, **98** (392), 701–19.

Best, M., Brockmeyer, A., Kleven, H. J., Spinnewijn, J. and Waseem, M. (2015). Production vs revenue efficiency with limited tax capacity: Theory and evidence from pakistan. *Journal of Political Economy*, **123** (6).

Boadway, R. and Sato, M. (2009). Optimal tax design and enforcement with an informal sector. *American Economic Journal: Economic Policy*, **1** (1), 1–27.

Cagé, J. and Gadenne, L. (2017). *Tax Revenues and the Fiscal Cost of Trade Liberalization, 1792-2006*. PSE Working Papers halshs-00705354, HAL.

Carlsson, F., Gupta, G. and Johansson-Stenman, O. (2003). Choosing from behind a veil of ignorance in India. *Applied Economics Letters, Taylor & Francis Journals*, **10** (13), 825–827.

Carrillo, P., Pomeranz, D. and Singhal, M. (2017). Dodging the Taxman: Firm Misreporting and Limits to Tax Enforcement. *American Economic Journal: Applied Economics*, **9** (2), 144–164.

Chetty, R. and Looney, A. (2006). Consumption smoothing and the welfare consequences of social insurance in developing economies. *Journal of Public Economics*, **90** (12), 2351–2356.

Coady, D., Grosh, M. and Hoddinott, J. (2004). *Targeting of Transfers in Developing Countries: Review of Lessons and Experience*. The World Bank.

Coate, S. (1989). Cash versus direct food relief. *Journal of Development Economics*, **30** (2), 199–224.

—, Johnson, S. and Zeckhauser, R. (1994). Pecuniary redistribution through in-kind programs. *Journal of Public Economics*, **55** (1), 19–40.

Cunha, J. M. (2014). Testing paternalism: Cash versus in-kind transfers. *American Economic Journal: Applied Economics*, **6** (2), 195–230.

—, Giorgi, G. D. and Jayachandran, S. (2017). *The Price Effects of Cash Versus In-Kind Transfers*. NBER Working Papers 17456, National Bureau of Economic Research, Inc.

Currie, J. and Gahvari, F. (2008). Transfers in cash and in-kind: Theory meets the data. *Journal of Economic Literature*, **46** (2), 333–83.

de Paula, A. and Scheinkman, J. A. (2010). Value-added taxes, chain effects, and informality. *American Economic Journal: Macroeconomics*, **2** (4), 195–221.

Deaton, A. (1997). *The analysis of Household surveys: a microeconometric approach to development Policy*. John Hopkins University Press.

— and TAROZZI, A. (2005). *Data and Dogma: The Great Indian Poverty Debate*, Macmillan India, New Delhi, chap. Prices and Poverty in India.

DEATON, P. K., ANGUS. and SUBRAMANIAN, S. (1994). Food demand patterns and pricing policy in maharashtra. *Sarvekshana*, **XVIII (2)**, 1–21.

DERCON, S. and KRISHAN, P. (2004). *Insurance Against Poverty*, Oxford University Press, chap. Food Aid and Informal Insurance.

DHARMAPALA, D., SLEMROD, J. and WILSON, J. D. (2011). Tax policy and the missing middle: Optimal tax remittance with firm-level administrative costs. *Journal of Public Economics*, **95** (910), 1036 – 1047, special Issue: The Role of Firms in Tax Systems.

DIAMOND, P. A. (1975). A many-person Ramsey tax rule. *Journal of Public Economics*, **4** (4), 335–342.

DREZE, J., KHERA, R. and PUDUSSERY, J. (2015). Food security. *Economic and Political Weekly*, **Vol. 50** (Issue No. 34).

EMRAN, M. S. and STIGLITZ, J. E. (2005). On selective indirect tax reform in developing countries. *Journal of Public Economics*, **89** (4), 599–623.

FACK, G. (2006). Are housing benefit an effective way to redistribute income? evidence from a natural experiment in france. *Labour Economics*, **13** (6), 747 – 771, evaluating Social Policy Changes in EU Countries (realized in collaboration with the National Poverty Centre and the European Union Centre at the University of Michigan).

FACKLER, P. L. and GOODWIN, B. K. (2001). Spatial price analysis. In B. L. Gardner and G. C. Rausser (eds.), *Handbook of Agricultural Economics*, vol. 1, Part 2, *17*, 1st edn., Elsevier, pp. 971–1024.

FARRAR, C. (2000). *A Review of Food Subsidy Research at IFPRI*. Tech. rep., IFPRI.

GADENNE, L., NORRIS, S., SINGHAL, M. and SUKHTANKAR, S. (2017). *Price risk and poverty*. Tech. rep., Ideas for India, http://www.ideasforindia.in/Article.aspx?article˙id=2811.

GERARD, F. and GONZAGA, G. (2016). *Informal Labor and the Cost of Social Programs: Evidence from 15 Years of Unemployment Insurance in Brazil*. Tech. rep., NBER Working Paper Nb 22608.

GHATAK, M. (2016). *Is India ready for a universal basic income scheme?* Tech. rep., International Growth Center.

GORDON, R. and LI, W. (2009). Tax structures in developing countries: Many puzzles and a possible explanation. *Journal of Public Economics*, **93** (7-8), 855–866.

Gundimeda, H. and Khlin, G. (2006). *Fuel Demand Elasticities for Energy and Environmental Policies Indian Sample Survey Evidence*. Energy Working Papers 22501, East Asian Bureau of Economic Research.

Hari, S. (2017). *Markets Subsidies and Corruption: Evidence from India*. Tech. rep., Mimeo, NYU.

Himanshu, A. S. (2013). In-kind food transfers i impact on poverty. *Economic and Political Weekly*, **Vol XLVI**.

IISD (2014). *Subsidies to Liquefied Petroleum Gas in India: An overview of recent reforms*. Tech. rep., International Institute for Sustainable Development,.

Jansen, G. and Malki, S. (2010). *Managing Food price inflation in South Asis*, The University Press Limited, chap. Managing food price inflation in Pakistan.

Jensen, A. (2016). *Employment Structure and the Rise of the Modern Tax System*. Tech. rep.

Kennedy, E. and Harold (1987). *Comparative Analyses of Nutritional Effectiveness of Food Subsidies*. Tech. rep., IFPRI.

Khan, A., Khwaja, A. and Olken, B. (2016). Tax farming redux. experimental evidence on incentive pay for tax collectors. *Quarterly Journal of Economics*, **6**.

Khandker, S. R., Barnes, D. F. and Samad, H. A. (2010). *Energy poverty in rural and urban India : are the energy poor also income poor ?* Tech. rep., Policy Research Working Paper WPS 5463, World Bank.

Khera, R. (2011a). Revival of the public distribution system: Evidence and explanations. *Economic and Political Weekly*, **Vol XLVI**.

— (2011b). Trends in diversion of grain from the public distribution system. *Economic and P*, **45**.

— and Dreze, J. (2013). Rural poverty and the public distribution system. *Economic and*, **Vol - XLVIII**.

Khullar (2017). *Demand for Grants 2017-18 Analysis: Food and Public Distribution*. Tech. rep., PRS Legislative Research.

Kleven, H. J., Kreiner, C. T. and Saez, E. (2016). Why Can Modern Governments Tax So Much? An Agency Model of Firms as Fiscal Intermediaries. *Economica*, **83** (330), 219–246.

— and Waseem, M. (2013). Using notches to uncover optimization frictions and structural elasticities: Theory and evidence from pakistan. *Quarterly Journal of Economics*, **128**, 669–723, preliminary Working Paper.

Kumar, P., Kumar, A., Parappurathu, S. and Raju, S. (2011). Estimation of Demand Elasticity for Food Commodities in India. *Agricultural Economics Research Review*, **24** (1).

Kumler, T., Verhoogen, E. and Fras, J. A. (2015). *Enlisting Employees in Improving Payroll-Tax Compliance: Evidence from Mexico*. NBER Working Papers 19385.

Maskin, E. and Riley, J. (1984). Monopoly with Incomplete Information. *RAND Journal of Economics*, **15** (2), 171–196.

Mooiji, J. (1999). *Food policy and the Indian state: the public distribution system in South India*. Oxford University Press, Ne.

Nagavarapu, S. and Sekhri, S. (2014). *Informal Monitoring and Enforcement Mechanisms in Public Service Delivery: Evidence from the Public Distribution System in India*. Tech. rep., Mimeo, Brown University.

Naritomi, J. (2016). *Consumers as Tax Auditors*. Tech. rep., Harvard University.

Nichols, A. L. and Zeckhauser, R. J. (1982). Targeting transfers through restrictions on recipients. *American Economic Review*, **72** (2), 372–77.

Niehaus, P., Atanassova, A., Bertrand, M. and Mullainathan, S. (2013). Targeting with agents. *American Economic Journal: Economic Policy*, **5** (1), 206–38.

Olken, B. A. and Singhal, M. (2011). Informal taxation. *American Economic Journal: Applied Economics*, **3 (4)** (15221), 1–28.

Pachauri, S., Mueller, A., Kemmler, A. and Spreng, D. (2004). On measuring energy poverty in indian households. *World Development*, **32** (12), 2083 – 2104.

Piketty, T. and Qian, N. (2009). Income inequality and progressive income taxation in china and india, 1986-2015. *American Economic Journal: Applied Economics*, **1** (2), 53–63.

Planning Commission (2005). *Performance Evaluation of Targeted Public Distribution System*. Tech. rep., Government of India.

Pomeranz, D. (2015). No taxation without information: Deterrence and self-enforcement in the value added tax. *American Economic Review*, **105** (8), 2539–69.

Ramsey, F. (1927). A contribution to the theory of taxation. *The Economic Journal*, **37**, 47–61.

Rao, V. (2000). Price Heterogeneity and "Real" Inequality: A Case Study of Prices and Poverty in Rural South India. *Review of Income and Wealth*, **46** (2), 201–11.

Ravallion, M. (2017). *Straw men in the debate on basic income versus targeting*. Tech. rep., Voxeu.org.

Rogers, B. L. and Coates, J. (2002). *Food-Based Safety Nets and Related Programs*. Working Papers in Food Policy and Nutrition 12, Friedman School of Nutrition Science and Policy.

Saez, E. (2001). Using elasticities to derive optimal income tax rates. *Review of Economic Studies*, **68** (1), 205–29.

— and Stantcheva, S. (2016). Generalized Social Marginal Welfare Weights for Optimal Tax Theory. *American Economic Review*, **106** (1), 24–45.

Sah, R. K. (1983). How much redistribution is possible through commodity taxes? *Journal of Public Economics*, **20** (1), 89–101.

Sahn, D. E. (1987). Changes in the living standards of the poor in sri lanka during a period of macroeconomic restructuring. *World Developmient*, **15**, 809–830.

Sheshinski, E. (1989). Note on the shape of the optimum income tax schedule. *Journal of Public Economics*, **40**.

Slemrod, J., Yitzhaki, S., Mayshar, J. and Lundholm, M. (1994). The optimal two-bracket linear income tax. *Journal of Public Economics*, **53** (2), 269–290.

Sukhtankar, K. M., Sandeep and Niehaus, P. (2011). *Assessing the Scope for Cash Transfers in lieu of the TPDS in Rural and Urban Bihar*. Tech. rep., JPAL South Asia.

Tarozzi, A. (2005). The indian public distribution system as provider of food security: Evidence from child nutrition in andhra pradesh. *European Economic Review*, **49** (5), 1305 – 1330.

Turnovsky, S., Shalit, H. and Schmitz, A. (1980). Consumer's surplus, price instability, and consumer welfare. *Econometrica*, **48** (1), 135–152.

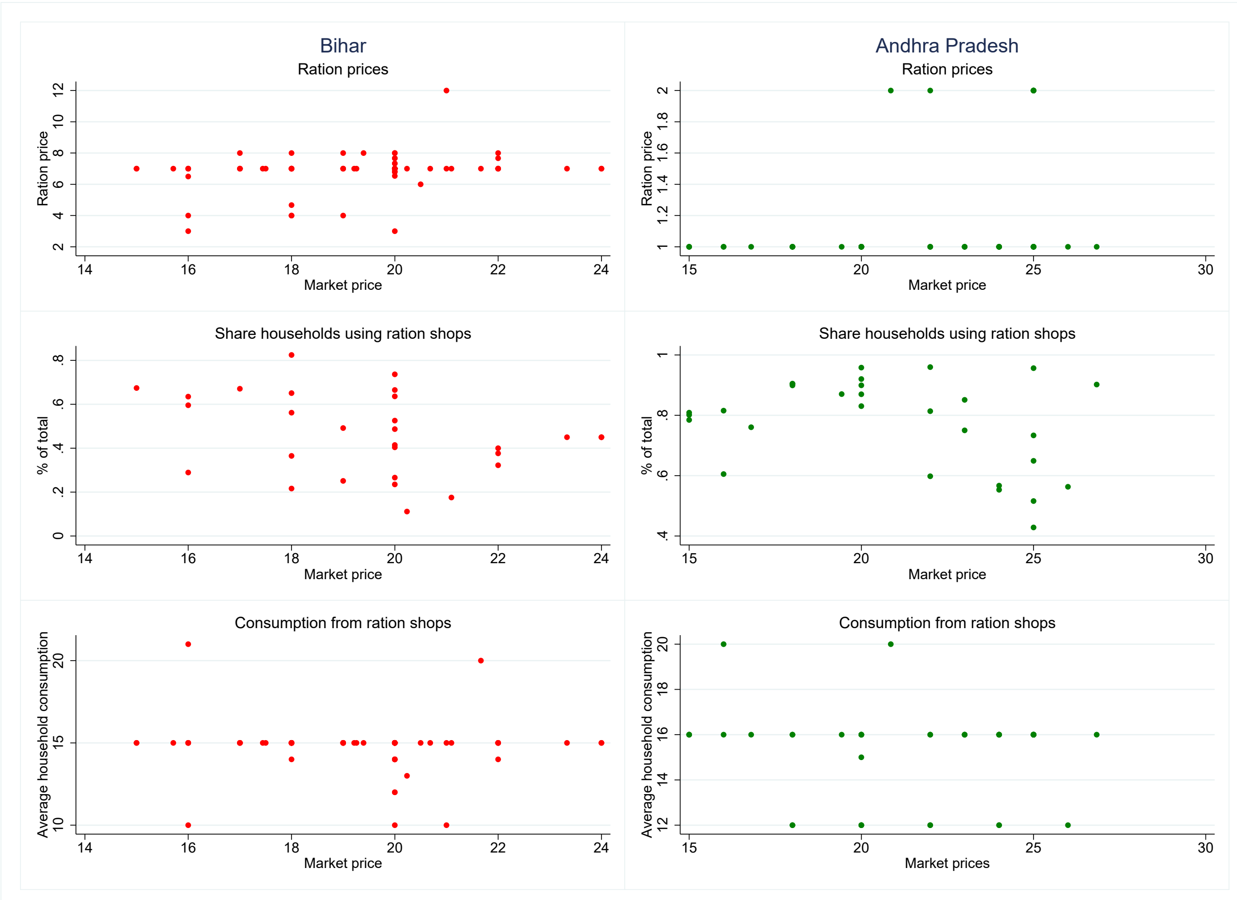
Varian, H. R. (1980). Redistributive taxation as social insurance. *Journal of Public Economics, Elsevier*, **14** (1), 49–68.

Ventura-Alfaro, C. E., Gutirrez-Reyes, J. P., BertozziKenefick, S. M. and Calds-Gmez, N. (2011). Anlisis de costo-eficiencia del programa de apoyo alimentario en mxico. *Revista de Salud Publica.*

World Bank (2012). *Raskin subsidized delivery, Social assistance program and public expenditure review.* Tech. rep., Public Expenditure review. Washington, DC: World Bank.

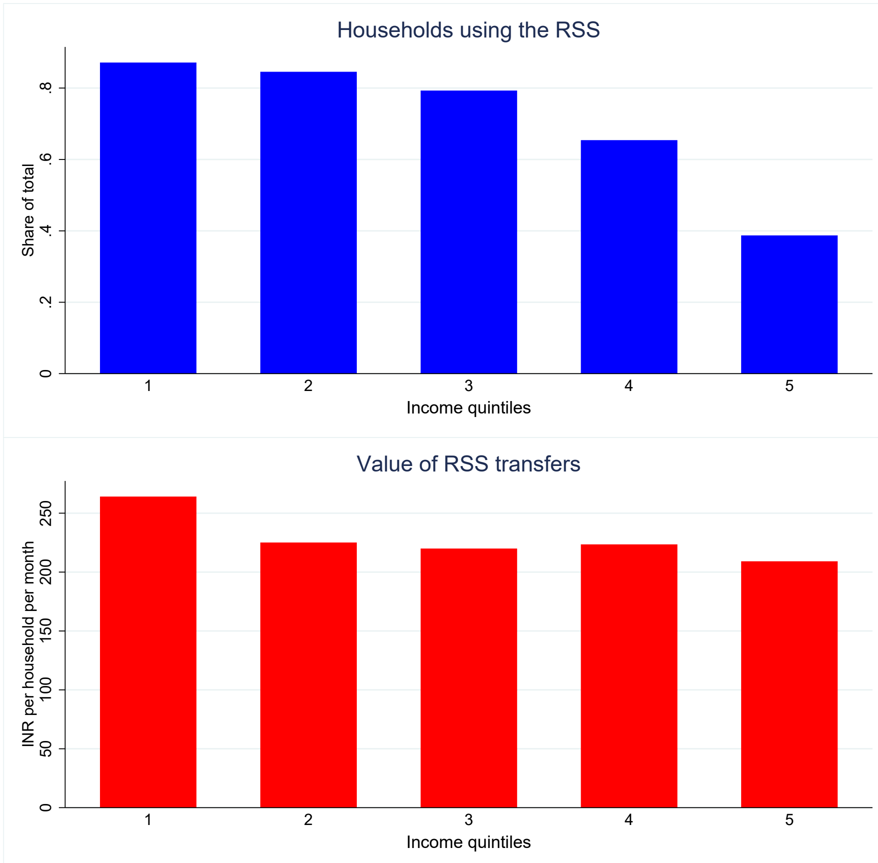
World Bank (2014). *The State of Social Safety Nets 2014*. The World Bank.

Figure 1: District level correlations between market prices and RSS characteristics for rice



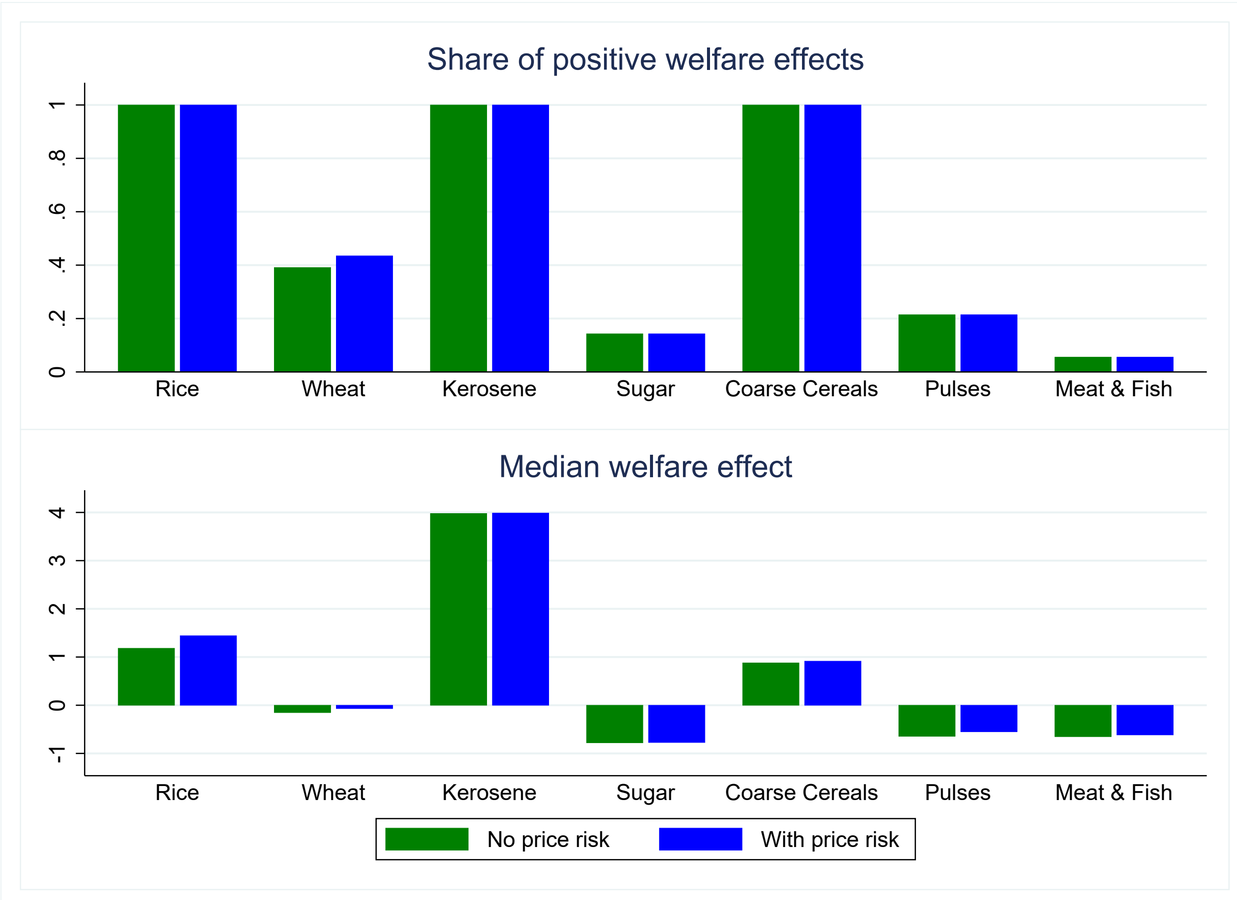
These graphs present the correlation between on the x-axis median market prices and on the y-axis i) median ration prices, ii) share of households using the PDS and iii) average consumption from ration shops, when positive. Each point represents a value for a sub-district, defined as the rural or urban part of a district. Prices are in INR per kilo and unit values are used as proxies for prices. Pairwise correlations (significance level) with market prices are i) in Bihar 0.244 (0.13) for ration prices, -0.300 (0.12) for % use ration shops and -0.06 (0.58) for average consumption and ii) in Andhra Pradesh 0.266 (0.08) for ration prices, -0.35 (0.07) for % use ration shops and -0.06 (0.69) for average consumption. for share consume All values are reported by households in the NSSO consumption survey 2011-2012, see the text for a description of the survey.

Figure 2: Use of ration shop system by income quintile



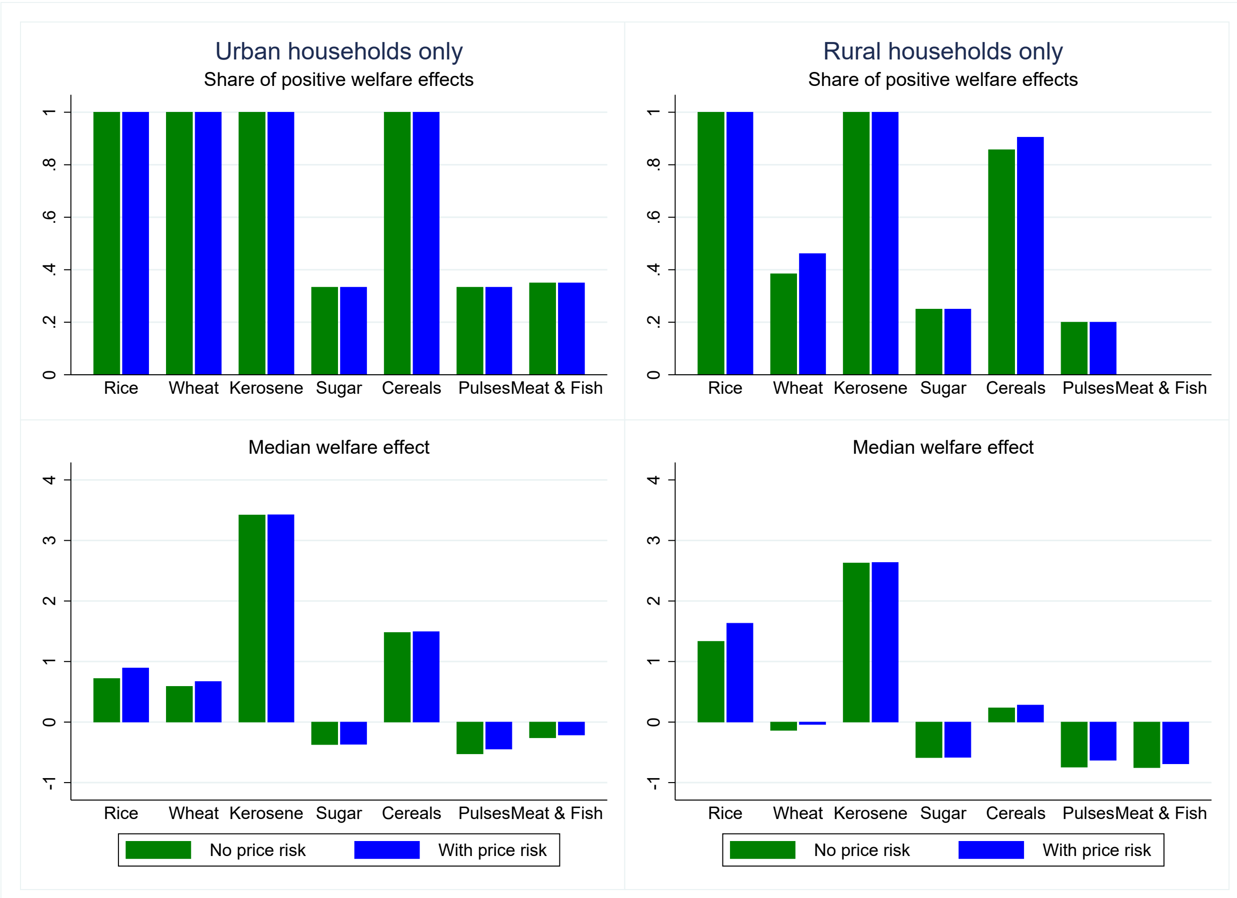
Each graph plots the distribution of a variable by quintile of total expenditure per capita. The top graph plots the share of households that use the RSS, the bottom graph the value of RSS transfers (conditional on using the RSS). Applying state-level poverty lines 22% of the population is categorized 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 3: Welfare effect of rations shop systems: additional results



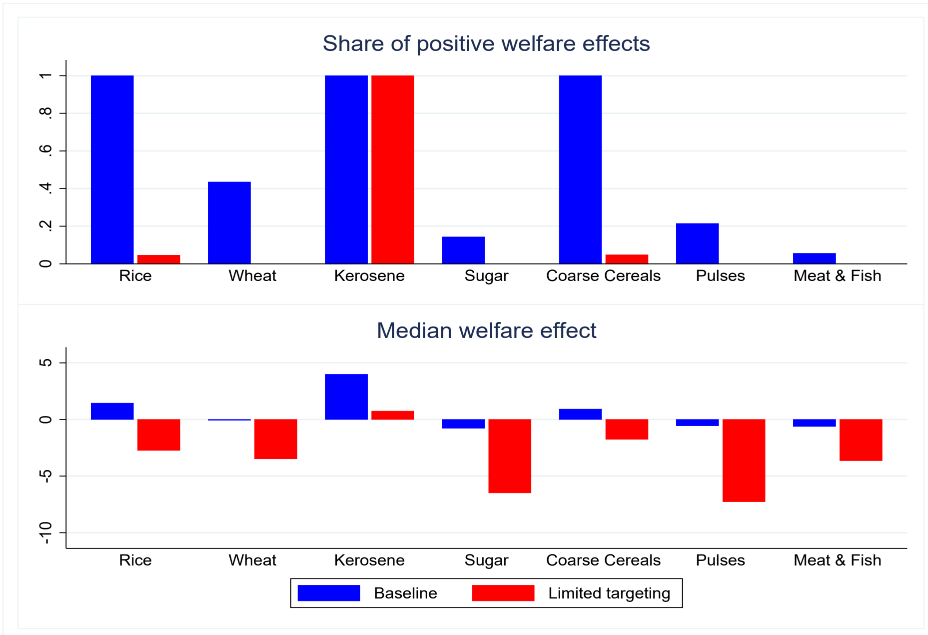
The top panel presents the share of quotas below the median total consumption levels for which the welfare effect of introducing a RSS is positive. The second panel presents the median welfare effect of introducing a RSS across quota levels. The green bars correspond to the welfare effect in a world without price risk - expression (4) - and the blue bars correspond to the total welfare effect in a world with price risk - sum of expressions (4) and (9).

Figure 4: 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. The green bars correspond to the welfare effect in a world without price risk - expression (4) - and the blue bars correspond to the total welfare effect in a world with price risk - sum of expressions (4) and (9).

Figure 5: Welfare effect of rations shop systems with limited targeting



The top panel presents the share of quotas below the median total consumption levels for which the welfare effect of introducing a RSS is positive. The second panel presents the median welfare effect of introducing a RSS across quota levels. The welfare effects are the sum of expressions (4) and (9). The blue bars correspond to baseline welfare effects, the red bars are obtained by assuming the government has access to a transfer that reaches the poor with probability $\hat{\pi} > \pi$, setting $\mu = \hat{\pi} g_p + (1 - \hat{\pi}) g_{np}$. I use results in Niehaus *et al.* (2013) to proxy for $\hat{\pi}$, see the appendix for a description of the method used.

Table 1: Ration shop systems around the world: some examples

Country	Program Name	Eligibility	Goods	Cost/Scope	Source
Bangladesh	Vulnerable Group Feeding	Targeted	Foodgrains	5% of government expenditures	Ahmed *et al.* (2009)
Ethiopia	Food aid	Quasi-universal	Cereals	5-15% of cereal production	Dercon and Krishan (2004)
India	Public Distribution System	Universal till 1997, partially targeted since.	Mostly rice, wheat, sugar and kerosene.	6% of total expenditures	Planning Commission (2005), Balani (2013)
Indonesia	Raskin	Targeted	Rice	55% of social assistance expenditure	World Bank (2012)
Mexico	Programa de Apoyo Alimentario	Targeted	Food	0.7% of GDP	Ventura-Alfaro *et al.* (2011)
Pakistan	Utility stores	Universal	Wheat	750 million USD in 2007/2008	Jansen and Malki (2010)
Sri Lanka	Food stamps	Universal till 1979, targeted since.	Rice, flour, sugar	5% of GDP (in the 1980s)	Farrar (2000), Sahn (1987)

I categorize any program that sells households goods up to a quota level at a fixed subsidized price (including for free) as a ration shop system. The third column refers to the rules set by the government to determine which type of households have access to the system, 'universal' means all households can use ration shops, 'targeted' means the government restricts access (at least in theory) to households that meet some criteria.

Table 2: Goods sold through the ration shop system: descriptive statistics

	Rice	Wheat	Kerosene	Sugar
A: Parameters of the system (source: state laws)				
Official quota (kg or litres per month)	5-25	5-25	2-5	0.5-2
Official ration price (INR)	0-9	1-9	13-17	12-16
B: Household consumption by source, kg or litres per month (source: survey data)				
All sources				
Mean (standard deviation)	30.9 (30.5)	27.5 (33.6)	3.1 (2.4)	3.5 (2.9)
Median	24.5	16	3	3
25th pctile	10	5	2	2
From ration shops				
Mean (standard deviation)	16.2 (9.2)	9.8 (8.6)	2.7(1.4)	1.5 (1.2)
Median	15	9	2.5	1.5
% Consume from all sources	97	91	76	98
% Consume from ration shops	39	30	64	29
% Consume from home production	15	14	0	0
C: Prices, INR (source: survey data)				
Market prices				
Mean (standard deviation)	21.8 (7.0)	17.7 (6.8)	29.1 (6.8)	32.9 (2.6)
Median	20	16	29	32
10th-90th pctile	14-35	10-28	20-40	30-36
Ration prices				
Mean (standard deviation)	3.2 (3.1)	5.9 (4)	15.6 (1.8)	15.1 (3.1)
Median	2	5.4	15.3	14
10th-90th pctile	1-7	2-10	14-17	13-17
D: Total consumption from ration shops (source: survey data)				
		Poor households	Non-poor households	
% Use ration shops		84.6	66.5	
Ration value (INR) - Mean (sd)		272.6 (216)	216.9 (213)	
Ration value (% total expenditure) - Mean (sd)		9.4 (9.3)	4.5 (5.2)	

Consumption is per month and measured at the household level, prices are in INR and quantities in kilos (rice, wheat and sugar) or litres (kerosene). Descriptive statistics for each variable are for households with non-zero value of this variable except for '% Consume' which is the share of households with positive consumption of the good. Ration values are equal to quantities purchased from ration shops times market price, summed over all goods purchased by the household from the ration shop system. The source used for Panels B to D is the NSSO consumption survey for 2011-2012, consumption and prices are as reported by households. In Panel D households are classified as poor and non-poor using state-level official poverty lines. See the text for a description of the data used and the Appendix for a state-level comparison of official ration quotas and prices and consumption from ration shops and ration prices as reported in the survey.

Table 3: Calibration parameters for each good

		Rice	Wheat	Kerosene	Sugar	Meat & fish	Coarse cereals	Pulses	Cooking gas
Distribution of consumption levels									
α		0.96	0.83	0.93	0.66	0.48	1.03	0.68	0.17
π_2	-10th pctile	0.22	0.19	0.27	0.19	0.18	0.22	0.19	0.05
	-25th pctile	0.21	0.19	0.25	0.15	0.15	0.22	0.17	0.04
	-50th pctile	0.20	0.20	0.22	0.11	0.10	0.21	0.11	0.02
α_2	-10th pctile	0.97	0.94	0.75	0.72	0.56	1.03	0.74	0.69
	-25th pctile	0.94	0.92	0.76	0.78	0.61	1.02	0.76	0.75
	-50th pctile	0.95	0.89	0.74	0.82	0.69	0.99	0.82	0.80
θ	-10th pctile	9.49	10.29	4.3	3.17	4.86	8.62	2.65	2.89
	-25th pctile	3.07	4.6	3.1	2.12	3.28	4.2	1.94	1.79
	-50th pctile	1.67	1.8	2.4	1.68	2.27	2.5	1.6	1.44
Demand parameters									
ϵ		0.2	0.3	0.5	0.3	0.8	0.2	0.4	0.5
η		0.02	0.08	0.7	0.06	0.7	-0.1	0.2	0.7
Price risk									
$\sigma(\%)$		6.66	6.52	6.46	2.74	5.29	7.05	5.63	3.54
Budget shares									
$s(\%)$	All	8.55 (5.31)	4.30 (2.65)	1.53 (1.59)	1.88 (0.68)	5.34 (2.73)	2.81 (2.46)	3.47 (1.03)	3.76 (1.01)
$s(\%)$	Poor only	12.1 (6.69)	7.07 (4.41)	2.39 (2.72)	3.37 (1.65)	7.40 (3.78)	4.28 (3.53)	5.81 (2.60)	8.2 (3.4)
Endowment shares									
$s_\omega(\%)$	All	1.48 (1.25)	1.03 (1.25)	0	0	0.15 (0.12)	0.91 (1.48)	0.25 (0.01)	0
$s_\omega(\%)$	Poor only	2.12 (1.80)	1.50 (1.99)	0	0	0.32 (0.44)	1.41 (2.19)	0.58 (0.01)	0

Mean (standard deviation). Each variable corresponds to a parameter in the model: α is the share of poor households' consumption in total consumption, $\alpha_2(q)$ is the share of poor households' consumption in total consumption amongst households consuming at least the quota amount q, $\pi_2(q)$ the share of poor households amongst households consuming at least q, $\theta(q)$ total consumption above q divided by q. For each good I consider values of q equal to the 10th, 25th and 50th percentiles of the distribution of consumption. ϵ and η are respectively price and income elasticities, σ is the coefficient of variation of the price of the good, s is the average budget share spent on the good (standard deviation in parentheses), s_ω is the average endowment share. Both s and s_ω are obtained on the sample of households purchasing positive amounts of the good as these are the relevant values in expression (9). Consumption levels are conditional on the goods being taxed at their optimal tax level. See the text for a description of the data and methodology used.

Table 4: Baseline results

	Redistribution effect			Insurance effect			Total effect		
Quota (Consumption percentile)	10	25	50	10	25	50	10	25	50
Rice	0.86	1.04	1.99	0.040	0.19	0.84	0.90	1.23	2.83
Wheat	0.57	0.21	-0.98	0.010	0.040	0.24	0.58	0.24	-0.74
Kerosene	2.53	3.86	6.17	0	0.010	0.020	2.53	3.87	6.18
Sugar	0.11	-0.93	-2.91	0	0.010	0.010	0.11	-0.92	-2.90
Coarse cereals	0.90	0.86	0.99	0.010	0.030	0.080	0.91	0.89	1.07
Pulses	0.060	-0.95	-2.31	0.050	0.090	0.20	0.11	-0.86	-2.11
Meat & fish	-0.030	-0.65	-2.24	0.020	0.030	0.080	-0.010	-0.62	-2.16
Cooking gas	-8.22	-20.0	-37.0	0.020	0.050	0.11	-8.20	-20.0	-36.9

The first three columns present the welfare effect of introducing a RSS in a world without price risk (expression (4)) 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 (9), and the last three columns are the sum of the two effects (expression (4) plus expression (9)). See the text for the description of the method and data used.