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Can Rationing Increase Welfare? Theory and An Application to India's Ration Shop System

By LUCIE GADENNE*

In many developing countries households can purchase limited quantities of good at a fixed subsidized price through ration shops. This paper asks whether the characteristics of developing countries explain why governments use such 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 of ration shops will be highest for necessity goods and goods with high price risk. I calibrate the model for India and find that ration shops are welfare improving for three of the four goods sold through the system today.
Keywords: Taxation, development, redistribution

Ration shop systems, which give households the right to purchase some goods at a fixed subsidized price up to a quota level, are widely used throughout the developing world – India's ration shop system alone is used by roughly 11% of the world's population. They have however attracted little attention in the literature (with some exceptions, see for example Tarozzi, 2005, Cunha, Giorgi and Jayachandran, 2019). Table 1 presents a non-exhaustive list of countries in which ration shop systems are in place, restricted to examples for which estimates of the cost of the program are available. Eligibility to use ration shops varies across countries but universal access is common.[1]

These systems enable governments to implement a particular form of commodity taxation: by subsidising purchases below a quota level through ration shops and 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. The use of such piece-wise increasing commodity taxes is hard to explain using standard optimal tax theory: nonlinear commodity taxes have been deemed unfeasible in most of the literature because of governments' inability to 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 should be reformed.

In this paper I ask under what conditions using a universal-access ration shop system is socially optimal in a developing country context. I start from the realization that these systems make a constrained form of nonlinear commodity taxes (piece-wise increasing taxes) feasible and ask under what conditions using these taxes increases social welfare compared to using only linear commodity taxes and universal lump-sum transfers. I take into account two particularities of the developing country context that may make ration shops attractive in these countries: limited government capacity to observe household incomes and high commodity price risk. First, governments in developing countries have limited capacity to observe household incomes, or targeting capacity (see Besley and Persson, 2013, Kleven, Kreiner and Saez, 2016, Jensen, 2019); 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

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[1]The history of ration shop systems is well documented in Alderman (2002), Rogers and Coates (2002).

[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)

regulations lead to poor spatial market integration in developing countries, as is well-documented by the trade literature (Fackler and Goodwin, 2001, Atkin, 2013, Atkin and Donaldson, 2015, Allen and Atkin, 2016). Consumer prices consequently co-vary strongly with local supply shocks (see also Bellemare, Barrett and Just, 2013). This introduces a potential *social insurance* motive for the use of ration shops that guarantee the price of goods up to a quota level.

This paper's first contribution is a model of commodity taxation that takes into account the characteristics of developing countries. I set up a Ramsey-type model of commodity taxes in which households differ in their preferences and incomes and face an exogenous price risk. This model allows me to consider, using a tax reform approach, under what conditions – what types of household and government preferences – using ration shop systems increases social welfare compared to using only linear commodity taxes.

I obtain general conditions under which ration shop systems (RSS) increase social welfare. There is a trade-off between efficiency and equity: an efficiency-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 has distributional concerns, 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). This is because taxing higher levels of consumption of these goods more affects richer households disproportionately, and most poor households benefit from the lower prices below the quota. Welfare effects are on the other hand mostly negative for both luxury and inferior goods. Finally, 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 and 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 which documents household consumption from ration shops, markets and home production. This survey is available annually; I use past editions to obtain proxies for the level of price risk faced by households. This calibration exercise allows me to sign the effect of introducing ration shops on social welfare for different commodities

and to compare the magnitude of these effects across commodities.

Calibration results suggest that introducing ration shops is welfare-improving for three commodities that are currently distributed through the ration shop system – kerosene, rice and (to a lesser extent) wheat. These three commodities 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 commodities as candidates for inclusion in India's RSS and find welfare gains for coarse cereals (which are staples in some parts of India), but not for any other good.

I then study the implications of relaxing some of 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. The US's food stamps policy for example offers households vouchers to purchase some commodities, but do not fix the price of these commodities and are targeted to the poor (see Hoynes, Schanzenbach and Almond, 2016). They are therefore not a form of ration shop system as defined in this paper. 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 capacity to target transfers only to poor households (as estimated by Niehaus et al., 2013) is taken into account in the calibration. Allowing for administrative and corruption costs also reduces the welfare gains of introducing a RSS; calibration results suggest these gains are wiped out in the Indian context when institutional leakages are 5-8% higher for the ration shop subsidies than for the alternative use of government funds (a universal transfer).

A large literature considers how governments in developing countries redistribute with limited capacity to observe households' incomes (see Coady, Grosh and Hoddinott, 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) or pecuniary redistribution through general equilibrium effects on market prices (Coate, Johnson and Zeckhauser, 1994); in particular Cunha, Giorgi and Jayachandran (2019) find that in-kind transfers decrease local market prices in remote areas of rural Mexico. This paper contributes to this literature by showing 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 such considerations once we take into account the characteristics of governments and markets in developing countries. I offer a rationale for the existence of ration shops in the developing world gener-

ally, and not only in remote areas in which effects of in-kind transfers on market prices lead to pecuniary redistribution. Moreover, and unlike explanations based on political economy or paternalism, this approach enables me to inform policy discussions by quantifying the welfare effects of including different types of commodities in a RSS for different government objective functions. The focus of this paper is also related to a smaller literature that considers how existing ration shop systems can be made more efficient by changing implementation procedures (see for example Sukhtankar, Muralidharan and Niehaus, 2011, Banerjee et al., 2017, 2018) or studies the effect of recent changes in India's ration shop systems (Khera and Dreze, 2013, Himanshu, 2013, Nagavarapu and Sekhri, 2014).

This paper also 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.[3] I show that under some conditions a form of commodity taxation that has largely been ignored by the literature can be a useful policy instrument in developing countries because of the characteristics of both governments (limited capacity to observe incomes) 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.

Finally this paper is the first to examine the welfare properties of piecewise-increasing commodity taxes for general consumption goods. A small literature in public finance has considered nonlinear 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 – which 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 a constrained form of nonlinear commodity taxation – piecewise increasing taxes – is optimal even in the absence of indicator goods when income taxes are not available. The model's assumptions are thus in the spirit of Ramsey (1927) (exogenous, non-taxable income), Diamond (1975) (heterogeneous preferences) and Varian (1980) (exogenous risk, here exogenous price risk). Methodologically, the focus on deriving formulas expressed as a function of parameters that can be estimated from standard datasets is similar to that of Saez (2001) (see also Sheshinski, 1989, Slemrod et al., 1994). Results can moreover be interpreted as an application to piece-wise commodity taxation of the key insight in Scheuer and Werning (2018) that nonlinear tax models are an application of linear tax models in which different consumption levels are treated as different sub-goods. The question asked in this paper is also related to Weitzman

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[3]See for example Olken and Singhal (2011), Kleven, Landais and Saez (2013), Pomeranz (2015), Bachas and Soto (2017), Cage and Gadenne (2018) as well as Emran and Stiglitz (2005), Boadway and Sato (2009), Dharmapala, Slemrod and Wilson (2011) for theoretical work on the topic.

(1974, 1977) which consider the relative merits of price and quantity controls to allocate a commodity; these papers however rule out policies that combine price and quantity controls, such as ration shop systems.[4]

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.

I. Ration shop systems in practice

A ration shop system 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 sales taxes (Gordon and Li, 2009). In this section I detail the example of India's ration shop system (RSS) 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 (Mooiji, 1999). The main four commodities sold in the more than 500,000 ration shops in the country are rice wheat kerosene and sugar; when sold on the market these goods are subject to value-added-taxes (VAT). The system is India's largest poverty alleviation program, both in terms of cost (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.

Each household is given a ration card that outlines the quotas and prices it is entitled to, and the specific ration shop it is allocated to (typically the one closest to its home). A household can only purchase its quota from this particular shop. In most states household identification relies on the Aadhar ID system, which was rolled out in India since the early 2010s and enables government services (including ration shops) to uniquely identify individuals using their fingerprints and iris scans. Households' ration entitlements, past ration purchases, and allocated ration shop are all stored electronically in what is known as the ePDS system; ration shop staff only sell goods to households after having identified them and checked both that they have been allocated to this shop and have not already

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[4]The analysis in Weitzman (1977) is in particular more relevant to understand the use of ration shops by countries during wars, as it considers the merits of price and quantity controls to allocate a commodity in limited supply, which was arguably the aim of wartime governments.

purchased their quota for the period.[5]

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. 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, Khera and Pudussery, 2015).Table 2 presents descriptive statistics for each commodity sold in the ration shop system. Panel A shows the range of official quotas and ration prices in place in 2011-2012 - see appendix section A1.4 for a description of the ration shop policies in each state. Panels B to D show consumption and prices of the commodities 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, 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.

There is substantial anecdotal evidence of corruption in the running of the ration shop system (Planning Commission, 2005, 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 appendix section A1.4 and find that they are similarly 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. Chakrabarti, Kishore and Roy (2016) finds some evidence going in this direction in some states 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) median 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 in which it is thought to be inefficient and corrupt (Bihar) (see Khera and Dreze, 2011). 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 first assume

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[5]Until 2017 it was thus not possibly for a household to buy its quota from two different ration shops. In recent years some states have introduced 'portability' in the ration shop system, giving households the right to purchase goods from any ration shops in their state. This was made possibly by the Aadhar-linked ePDS system, which only authorises ration shop staff to sell to a household if that household has not already purchased its ration this month.

perfect implementation in modelling the RSS below then allow for corruption and administration costs in a model extension and in the calibration.

Table 2 and Figure 1 also show that there is substantial variation in market prices for all commodities except sugar. In addition Figure A2 in the appendix considers variation in commodity prices within market over time by plotting (deflated) median market prices in each quarter in the two largest regions over the period 2004-2012; we see that prices vary by up to 30% over time during this period. This high level of price variation across regions and within regions over time is in line with evidence 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. High levels of price risk are a pervasive characteristics of markets in developing countries more generally (Atkin and Donaldson, 2015).

The last panel of Table 2 presents descriptive statistics on total consumption from ration shops for poor and non-poor households, using the official poverty line and households' total expenditures to define their poverty status. We see that a large majority of both poor and non-poor households report using the RSS but there is some targeting of subsidies: among households using ration shops the monetary value of transfers is 20% higher for the poor than the non-poor. Figure 2 shows that this limited targeting is not only due to mis-targeting close to the poverty line, set at the 22nd percentile of the distribution: 65% of households in the fourth income quintile report using ration shops. India's RSS is indeed only partially statutorily targeted to the poorest households: the typical Indian state gives all households a right to purchase goods from ration shops but grants non-poor households less generous entitlements (lower quotas or higher ration prices).[6] Overall Indian states seem unable to effectively target transfers to poor households, in line with survey evidence in Niehaus et al. (2013). Limited targeting capacity is a concern for redistribution policies in all developing countries: 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 in the baseline model below and relax this assumption in an extension.

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

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[6]There could also 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. In appendix A1.4 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 in the one state (Tamil Nadu) in which all households have the same entitlements, households in the richest quintile are only 20% less likely than those in the poorest quintile to use ration shops; this suggests 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 among states with very different entitlements for the poor and non-poor.

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 resale of quotas but I use information on how much households consume from the ration shops enables me to assess the ease with which households could resale in this context: if resale 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 this is the case for 23% of households for rice, 11% for sugar and 33% for kerosene. The evidence suggests that resale 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 assumptions. Regarding policy instruments I assume perfect implementation of the ration shop system, no government targeting capacity (no income taxes or transfers), and no re-sale. I discuss the impact of relaxing these assumptions at the end of the model section.I introduce varying market prices in section II.C.

II. Model

This section uses a tax reform approach to consider whether ration shop systems improve social welfare. This allows me to characterize under what conditions – for what kind of household and government preferences – introducing a ration shop system is welfare increasing. Details of all calculations and proofs of all statements made can be found in the paper's appendix A1.

I assume the government has access to only two types of commodity tax schedules: linear commodity tax rates and ration shop systems, which implement piecewise increasing commodity taxes. Household income is exogenous and cannot be observed by the government so income taxes are unavailable. In this setting commodity taxes increase welfare if they help the government redistribute by approximating the first-best optimal nonlinear income taxes with a minimal efficiency cost.

Whilst ration shop systems implement nonlinear commodity taxes, they fall short of enabling the government to implement a nonlinear tax on household total consumption (equivalent here to a nonlinear income tax), for two reasons. First, under a nonlinear consumption tax the marginal tax rate paid by each household on any given commodity is a function of that household's total consumption of *all* commodities. Under a ration shop system the tax rate on any commodity is a function of the household's consumption of that commodity only. Second, a ration shop system only enables the government to implement a constrained version of a nonlinear tax schedule on each commodity: this schedule is constrained to be

piece-wise and increasing. I assume the government cannot implement piece-wise decreasing tax schedules, as these can only be implemented when the government has a monopoly on the retail of the good.[7]

Both these factors imply that ration shop systems are a less effective redistributive tool than a nonlinear tax on total consumption. However the government needs a lot less information to implement ration shop systems than to implement a nonlinear-consumption tax. To implement a nonlinear tax on total consumption the government needs to know total consumption of each commodity by each household in every period. To implement a ration shop system it only needs to know that each household consumes at most a quota amount of a commodity at the subsidized price; this can be done through a network of ration shops and a system that uniquely identifies households.

A.   Set-up

There is a continuum of mass 1 of households i that differ in their exogenous 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}, her uncompensated price elasticity of demand, and η_{ik}, her income elasticity of demand. I write $v_i(.)$ the household's indirect utility function, s_i^k the budget share she spends on good k and $p^k(x_i^k)$ the tax-inclusive price of k; households maximize utility subject to a standard budget constraint $\sum_k x_i^k p^k(x_i^k) \leq y_i$. In this section I simplify the analysis by assuming that all cross price effects are negligible, this allows me to consider the optimal tax schedule on each good k separately and drop all superscripts k in what follows. This assumption is discussed below and relaxed in the appendix.

I consider below whether introducing a ration shop system for a good is welfare-improving compared to setting an optimal linear rate t such that $p(x) = z + t$. I define a ration shop system by a set t_1, q, t_2 such that the marginal price of the good is given by:

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

where $t_2 > t_1$, q is strictly bounded by the minimum and maximum values of

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[7]The government needs full knowledge of each household's consumption of the good to implement piece-wise decreasing taxes, so that households consuming large amounts of the good can be charged a lower price. This can only be implemented through a system in which the good is only sold in government-controlled shops. In addition the government needs an instrument to prevent households from buying large amounts as a group and then splitting quantities among themselves. The government does have a monopoly on the supply of utilities in some countries, but I abstract from considering the merits of nonlinear pricing of utilities in this paper. On this topic see Sharkey and Sibley (1993) and Meran and von Hirschhausen (2017).

consumption of the good and equilibrium consumption x_i is given by:

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

The distributions of households' incomes and preferences yield a distribution of consumption with density $h(x)$ and cumulative density function $H(x)$.

Government preferences are characterized by the social welfare function $G(.)$, increasing and concave to reflect distributional concerns, and μ, the marginal value it places on one unit of public revenues. The government thus chooses tax instruments to maximize the following:

$$(1) \qquad\qquad W = \int_i G(v_i(p, y_i))di + \mu t \int_i x_i di.$$

I write household i's social welfare weight - the value the government places on one extra unit of income to household i - as g_i, and use these weights to aggregate money metric gains from introducing a RSS across households. I sometimes refer below to the particular case $\mu = g$, where g is the average social welfare weight; this corresponds to a situation in which the government's alternative use of funds is a universal (non-distortive) transfer. 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 $g_p > g_{np}$, and write π the share of poor households in the population. This 'poverty-averse' 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 error (Deaton, 1997).[8]

The analysis below considers the introduction of a ration shop system as a small deviation away from the optimal linear rate that maximizes expression (1). This optimal linear rate is given by:

$$(2) \qquad\qquad \frac{t^*}{z + t^*} = \frac{(\mu - g) + (g_p - g_{np})\pi(1 - \alpha)}{-\mu\epsilon},$$

where $\epsilon = \frac{\int_i \epsilon_i x_i di}{\int_i x_i di}$ is the weighted average uncompensated elasticity of demand, and $\alpha = \frac{\int_{i \in P} x_i di}{\pi \int_i x_i di}$ is the ratio of average consumption of poor households to average

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[8]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. The appendix presents results obtained using more general government preferences imposing only that $\frac{\partial g_i}{\partial y_i} \leq 0$; all results are qualitatively unchanged.

consumption of all households.[9] Equation (2) is Diamond (1975)'s many-person Ramsey rule for a poverty-averse government. The optimal linear rate is increasing in the government's preference for revenues over transferring income to the average household $(\mu - g)$ and decreasing in the share of consumption done by the poor. When $\mu = g$ the optimal linear rate is positive for normal goods $(\alpha < 1)$ and negative for inferior goods.

B.   Ration shop systems as redistribution policy

There are two ways to think about the effect of introducing a ration shop system: as a small decrease in t^* on consumption below q or a small increase in t^* on consumption above q. As shown in the appendix these two approaches are equivalent; both yield the following proposition which characterizes the welfare effect of introducing a ration shop system for any quota level q.

PROPOSITION 1:   *The welfare impact of introducing a ration shop system at quota level q, $dW^R(q)$, can be written as:*

$$(3) \quad dW^R(q) = \mu \frac{t^*}{z + t^*}\left(\frac{\epsilon_2^c(q)}{\theta - 1} - \epsilon + \epsilon_2(q)\right) + (g_p - g_{np})\left(\pi\alpha - \pi_2(q)\frac{x_{2p}(q) - q}{x_2(q) - q}\right)$$

where the suffix $_2$ indicates an average value among all households consuming at least an amount q of the good: $\epsilon_2^c(q) < 0$ is the average compensated demand elasticity among these households, $\pi_2(q)$ is the share of poor households among them, x_2 (x_{2p}) is average consumption of all households (poor households) consuming at least q, 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 the good.

Proof. See Appendix A1.1.

The welfare effect of introducing a ration shop system can be decomposed into two parts: an efficiency effect (first term in expression (3)) and a redistribution effect (second term). The first term captures how introducing a RSS affects tax revenues by changing households' consumption behavior. When household preferences are homogeneous $(\epsilon_2(q) = \epsilon)$ the efficiency effect is of opposite sign to the optimal linear rate; its magnitude is increasing in the compensated elasticity of demand of households consuming at least q. Intuitively, this is because the effect of introducing a RSS on households consuming at least q can be decomposed into two parts, depicted in Figure 3. First, there is an an increase in the marginal price of the good by dt_2, this changes the slope of the budget constraint; second, there is an increase in their virtual income by dt_2q which partially compensates for the increase in price, this shifts the budget constraint outwards. This decreases their

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[9]I assume throughout that uncompensated elasticities are negative for all goods.

consumption of the taxed good, the more so the higher their compensated elasticity of demand. Assuming $\mu = g$ and homogeneous preferences this behavioral response has a negative effect on the government budget when the good is normal (and a positive effect for inferior goods). Moreover, an increase in the thickness of the right-hand-side of the distribution of consumption, $\theta(q)$, decreases the magnitude of this behavioral effect. 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.

The efficiency effect will on the contrary be of the same sign as the optimal linear tax rate when preferences are heterogeneous if households with a high level of demand for the good have sufficiently low (in absolute value) price elasticity of demand compared to the average.[10] The intuition is the following: when households with high demand are also substantially less price-elastic than the average, introducing a RSS shifts the burden of taxation towards the least elastic parts of the distribution of consumption. This lowers the efficiency cost of taxation when the tax is positive, leading to a positive efficiency effect for normal goods. It implies that a government whose aim is purely to maximize revenue will thus not find it optimal to use a RSS unless the price elasticity of demand is strongly decreasing with consumption: for this government $(g_p - g_{np}) = 0$ and the optimal linear rate is positive, so the effect of introducing a RSS is negative unless demand elasticities are very heterogeneous.[11]

Unless preference heterogeneity takes a very specific form, introducing a RSS will therefore only be socially optimal if it enables the government to redistribute.[12] The redistribution effect (second term in (3)) captures how introducing a ration shop system affects the relative burden of taxation borne by the poor and the non-poor; it is a function of the relative distribution of consumption among these two groups of households and the strength of the government's redistributive preferences $(g_p - g_{np})$. Introducing a RSS increases the taxes paid by households with high levels of demand relative to those with low levels of demand. Given the government's preferences $(g_{np} < g_p)$ this will lead to a positive redistribution effect when households with high demand are less likely to be poor than the average – when the good is a normal good – and a negative effect otherwise. An alternative way to reach this conclusion is to compare the redistributive effect of an increase in the linear rate by dt to that of the introduction of a RSS, an increase in the linear rate by dt_2 only for consumption above q. The first option would increase taxes paid by all households i by an amount $dt x_i$. A RSS on the other hand increases the taxes paid by households consuming at least q by an

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[10] Formally the condition is $\epsilon_2(q) > \frac{\eta_2 s_2 + (\theta(q) - 1)\epsilon}{\theta}$.

[11] The intuition behind this result is similar to that behind the Maskin-Riley quantity-discount result for profit-maximizing monopolist (Maskin and Riley, 1984); a revenue-maximizing government has the same objective function as a monopolist as it sole aim is to minimize the efficiency cost generated by the tax system. With homogeneous preferences the optimal tax for this government is therefore a piece-wise *decreasing* tax schedule.

[12] Heterogeneous demand parameters only affect the efficiency cost of the RSS, I assume homogeneous preferences in what follows for simplicity.

amount $dt_2(x_i - q)$. This redistributes relative to an increase in the linear rate as long as the government places a higher weight on households consuming less than q than on households consuming at least q, ie as long as consumption of the good is increasing with income.

The total welfare effect of introducing a RSS is positive for normal goods when the positive redistribution effect outweighs the negative efficiency cost. It is largest for commodities for which the ratio of poor consumption to average consumption among all households (α) is large relative to the value of this ratio among households consuming at least q $(x_{2p}(q)/x_2(q))$, and few poor households consume in large amounts (low $\pi_2(q)$): these are goods that most poor households consume, but rarely in high amounts – necessity goods. For these goods the efficiency cost is low because a high α decreases the optimal linear rate, and the low values of $x_{2p}(q)/x_2(q)$ and $\pi_2(q)$ imply that the higher rate for high consumption levels is effectively targeted to the non-poor, maximizing the redistribution gain.[13] The welfare effect will also be higher the thicker the right-hand side of the distribution and the lower the compensated elasticity of demand, as this decreases the magnitude of the efficiency cost. On the contrary the total welfare effect is unlikely to ever be positive for luxury goods – goods that are hardly ever consumed by the poor: the welfare effect in expression (3) is negative for small values of α even when no poor household consumes more than the quota level.

Finally, note that introducing a RSS is unlikely to lead to welfare gains for goods with negative income elasticity. Such goods are characterized by $x_{2p}(q)/x_2(q) > \alpha$ and $\pi < \pi_2(q)$, so the redistribution effect in (3) is negative. 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. The welfare effect can however 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 ($x_2(q) > x_{2p}(q)$ and/or $\pi_2(q) < \pi$): 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.

Overall expression (3) shows that, for normal goods, introducing a RSS enables the government to redistribute more than simply using a linear tax, by taxing the non-poor without taxing the poor. In most cases this redistribution gain comes at an efficiency cost due to the fact that introducing a RSS further distorts prices away from the first best. Which effects dominates is a function of the relative

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[13]One can also apply the key insight in Scheuer and Werning (2018), that nonlinear taxation is linear taxation of different consumption levels treated as different goods, and note that the welfare gain of introducing a RSS is maximized when the optimal tax rate on consumption below q is lowest compared to the optimal tax rate above q, ie when consumption below the quota is an inferior good whilst consumption above the quota is a luxury good. Commodities with such highly non monotone Engel curves are in practice uncommon; among the set of commodities with monotone Engel curves necessity goods best approximate this scenario.

distribution of consumption among the poor and the non-poor, the thickness of the right-hand-side tail of the distribution, and the compensated elasticity of demand.

C. Ration shop systems as insurance against price risk

Consider now a world in which the price z of the good varies at the household level, and assume the prices of all other goods are held constant (this assumption is relaxed below). Each household faces the same probability distribution of z, symmetric around a mean $\bar{z}$ with coefficient of variation σ. Households' risk preferences are characterized by their relative risk aversion coefficient r. A ration shop system now sets the price of the good equal to a fixed price $\tilde{z} \leq \bar{z}$ below a quota level q.[14]

My assumptions imply that the government is able to provide each household with a quota level of the good at a fixed price but markets cannot: this is a good approximation of the Indian context, in which retail markets are under-developed because of high transport costs and regulatory barriers to trade, but the government is not subject to these regulations and is willing to pay the costs. The first-best option available to the government in this context would be household transfers indexed to local prices, but in practice it is unrealistic to assume the government can observe local realization of prices in real time (a RSS only assumes the government observes the average price $\bar{z}$).

Introducing a ration shop system is now equivalent to introducing both a piece-wise linear tax (a fixed decrease in the tax rate by $\bar{z} - \tilde{z}$ on consumption below q) and a 'price stabilizing transfer' $z - \bar{z}$ indexed on consumption up to the quota level q, on top of the optimal linear tax. The welfare effect of price-indexed transfers is governed by the impact of prices on the marginal utility of income v_{yi}, given by:

$$(4) \qquad \frac{\partial v_{yi}(y_i, z)}{\partial z} = \frac{v_{yi}(y_i, z)}{z + t} s_i(z)[r - \eta].$$

This equation implies that zero-expected-value transfers increasing with market prices will increase households' indirect utility as long as their relative risk aversion is high relative to their income effect, because they transfer positive amounts when households value income more. I assume throughout that $r > \eta$ so that there are gains from social insurance.[15]

The optimal linear commodity tax rate is therefore increasing in the level of price risk (see appendix for a proof). Intuitively, this is because a commodity tax

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[14]In what follows I assume that demand parameters ϵ, r and η are homogenous across households and do not vary with the market price z, and define g_i as the social value of giving household i an extra unit of income when the price is equal to $\bar{z}$.

[15]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 commodities considered in the calibration below are).

taxes households less in states of the world in which they consume less and their marginal utility of income is higher, thereby providing them with insurance (see Varian (1980) for a similar argument with respect to income taxes). It implies that introducing a piece-wise increasing linear tax in a world with price risk has a higher efficiency cost (because the optimal linear rate is higher) but also has a positive insurance effect on households consuming more than q, which now face a higher tax.

The price stabilization component of the RSS transfers an amount $(z - \bar{z})q$ to households consuming at least q. This transfer has mean zero but a positive welfare effect because it provides these households with partial insurance against price risk. In addition, the price stabilization component sets the marginal price faced by households consuming less than q to $\bar{z}$, the welfare effect of this is ambiguous and a function of $s_i(r - \eta) + \epsilon$, as first derived by Turnovsky, Shalit and Schmitz (1980). Intuitively, when the relative price of a good increases households can buy less of the good (an indirect utility loss) but they can substitute their consumption across states of the world to maximize their total consumption (an indirect utility gain). Households with less elastic demand will substitute their consumption away from the good less when its price increases and are more likely to experience an indirect utility loss. The price stabilization transfer to households consuming less than q however also raises revenues as these households receive consumption-indexed transfers that are positive when consumption is low and negative when consumption is high. The total welfare effect of stabilizing the price of the good for household i consuming less than q is therefore of the same sign as $g_i[s_i(r - \eta) - \epsilon] - \mu\epsilon$, which will be positive as long as ϵ is small or the government values public revenues more than the welfare of household i.

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

PROPOSITION 2: *The welfare effect of introducing a ration shop system at quota level q in a world in which the price of the good varies, $dW^P(q)$, can be written as:*

$$dW^P(q) = \mu \frac{t^{**}}{\bar{z} + t^{**}} \left(\frac{\epsilon_2^c(q)}{\theta - 1} - \epsilon + \epsilon_2(q) \right) + (g_p - g_{np}) \left(\pi\alpha - \pi_2(q) \frac{x_{2p}(q) - q}{x_2(q) - q} \right)$$

$$(5) \qquad + \frac{\sigma^2}{(x_2(q) - q)(1 - H(q))} \Big[-\epsilon(r - \eta) \int_{x_i \geq q} g_i x_i s_i \, di +$$

$$(\bar{z} + t)(r - \eta) \Big(\int_{x_i < q} g_i x_i s_i \, di + q \int_{x_i \geq q} g_i s_i \, di \Big) + \epsilon(\bar{z} + t) \int_{x_i < q} (g_i - \mu) x_i \, di \Big]$$

where t^{**} is the optimal linear rate adjusted for price risk, defined in the appendix (expression (A14)). The first line and second line represent the effect of introducing a piecewise increasing tax without a price stabilization component, the third line is the effect of the price stabilization component.

Proof. See Appendix A1.2.

The first two lines of (5) represent the effect of introducing a piece-wise increasing tax in the presence of price risk which can be decomposed into three parts. The first line contains the efficiency effect, which is now a function of the optimal linear rate adjusted for price risk, and the redistribution effect, unchanged from expression (3) above. The second line captures the insurance effect of increasing the tax on households consuming more than q, which is always positive. The third line represent the effect of introducing a price stabilizing transfer, the first term reflect the insurance value of this transfer and is always positive, the second term is due to the change in marginal price faced by households consuming less than q, which has a positive effect on government revenues but a negative on on households' indirect utility. Assuming $\mu = g$ this last term will be negative for normal goods and positive for inferior goods.

I define the insurance effect of introducing a RSS as the difference between the welfare effects in expressions (3) and (5). This insurance effect will be positive for most values of the parameters for normal goods, unless households are very responsive to changes in prices – in this case they value the insurance less and the efficiency cost (price distortion) of the 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 among the poor.

D. Extensions

Three of the model's assumptions can be relaxed in a simple way to more closely reflect the context of developing countries.[16] First, most developing countries can exclude some non-poor households from receiving subsidies. 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 $1 - \hat{\pi}$. Comparing this to a setting in which the government has no targeting capacity I show that the total welfare effect of introducing a RSS is decreasing in the government's targeting capacity: the redistribution effect from ration shops is more likely to be negative the better the government's alternative redistributive instrument. The effect is always negative when the government can perfectly target poor households, as is arguably the case in most developed countries.

Second, I relax the assumption of no administrative or corruption costs of introducing ration shops. I assume that for each unit transferred to households through the RSS the government must spend $(1 + \beta)$ units where $\beta > 0$ is the leakage rate. The leakage rate is zero for the lump sum transfer, so this is the leakage rate in the RSS relative to the alternative use of public funds. This decreases the welfare effect of introducing ration shops, the more so the higher the

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[16] All of these assumptions are formally relaxed in appendix A1.3.

leakage rate, the higher the value the government places on public revenues μ and the lower the revenue potential of taxing higher levels of consumption $\theta(q)$.

Third, I consider what happens if households can produce the good at home by assuming that each household is endowed with an exogenous amount of the good which she can sell at market price or consume.[17] These endowments provide households with some insurance against price risk by indexing part of their income to prices, and therefore decrease the overall insurance effect of introducing a RSS. The insurance effect will be lower for goods for which endowments represent a higher share of income on average and a larger share of poor households' incomes. I consider the impact of relaxing all these assumptions in the calibration results for India below.

The paper's appendix finally discusses the impact of relaxing the model's convenience assumptions. I allow for the taxation of several goods at the same time. This affects the efficiency effect of introducing a RSS because the tax on one good affect the taxes collected on all other goods; this extra efficiency term cannot be signed a priori as it is a function of cross-price demand elasticities. There elasticities are typically much smaller than the own-price elasticities (see Deaton, Parikh and Subramanian, 1994) so this extra effect is orders of magnitude smaller than the efficiency effect generated by own-price elasticities. I also allow the prices of several goods to vary at the same time. This changes the insurance effect of the ration shop system: assuming households spend the same budget share on two goods, when their prices are perfectly negatively correlated there is no need for social insurance, when they are perfectly positively correlated insurance against variations in the price of one of the goods is more valuable. 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 these goods in a similar way. Focusing on price risk for one commodity at a time, as I do in the calibration, probably under-estimates the total insurance effect of introducing ration shops. Again, this is likely second order because correlations are small.

III.   Data and method

This section details the data and method used to estimate the effect of introducing ration shops on social welfare in India in 2011-2012 by calibrating expressions (3) and (5) above.

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[17]See Table 2 for evidence that part of households' consumption of cereals comes from home production.

A. Data

The main data source used is 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, 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 & fish products'.[18] 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 & fish products in the last month, 98% consumed pulses. 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 a linear subsidy but in 2013 set a household-level quota on the amounts subsidized, effectively introducing a RSS for cooking gas (IISD, 2014). Including cooking gas in the calibration allows for an evaluation of the welfare effect of this policy change.

Households to report for each good i) their purchases from the ration shops ii) their market purchases iii) their consumption from home production. They 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.[19]

This survey is typical of consumption surveys that are routinely done in developing countries, it is of high quality but has some limitations (see Deaton, 1997). 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 lines are computed using estimates of households' total expenditures from the NSSO surveys and are designed to be applied to this total expenditures variable.[20]

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[18]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 appendix.

[19]The survey reports households' consumption of each good from their home production but not how much they produce, see the appendix for a description of how I estimate each household's home production endowment.

[20]This method likely underestimates the income of the richest households, which also tend to be underrepresented in consumption surveys. 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.

B. *Household and government preference parameters*

My calibrated values of the price and income elasticities come from two sources: Kumar et al. (2011) for the food commodities and Gundimeda and Kohlin (2006) for kerosene.[21] Both Kumar et al. (2011) and Gundimeda and Kohlin (2006) use the NSSO household survey to estimate average elasticities across all Indian households. To assess the robustness of my results to the value of these demand elasticities I also consider estimates obtained by Deaton, Parikh and Subramanian (1994) for a sample of households in Maharashtra. I use a relative risk aversion coefficient value of 3 as a baseline, in line with experimental estimates from India in Carlsson, Gupta and Johansson-Stenman (2003), 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 that its alternative use of funds is a universal lump-sum transfer by setting the marginal value of public funds (μ) equal to the average welfare weight g.

Expressions (3) and (5) cannot be directly calibrated using the distributions of consumption in the survey because consumption levels in the survey are affected by existing taxes and subsidies. To calibrate the welfare effects of introducing a RSS one needs to know counterfactual consumption levels in a context in which the optimal linear rate is levied, this optimal linear rate is itself obtained by using counterfactual consumption levels in the absence of all taxes and subsidies. To simulate counterfactual consumption for alternative tax schedules I take linear approximations 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.[22] 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.[23]

C. *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 annual NSSO house-

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[21]There is no evidence regarding how demand elasticities differ across household groups in India. I assume for simplicity that price and income elasticities are homogeneous across households.

[22]Formally, I start by simulating each household's consumption in a world with no taxes and use this to compute optimal linear rates for each good. I then simulate consumption in a world in which the optimal rates are levied to compute the welfare effects.

[23]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 in the absence of the RSS.

hold surveys for the years 2002-2003 to 2011-2012. I define a market as the lowest geographical unit at which the surveys are representative in all years - the rural and urban parts of each of the 77 NSS regions (hereafter sub-regions). I deflate all unit values using the mean all-India unit value for each good in each quarter to get rid of secular increases in prices due to inflation, and use within sub-regions variation across quarters in median deflated unit values to proxy for the coefficient of variation σ for each good. 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 because they are more likely to live in remote rural areas. I therefore 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. See appendix A3.3 for more details on how I construct measures of price risk.

D. *Calibration parameters*

Table 3 presents the value of the parameters that enter the expressions for the welfare effect of ration shop systems for each good category. I first present characteristics of the distribution of consumption at the 10th, 25th and 50th percentiles of the distribution of consumption: the ratio of average consumption by the poor to average overall consumption (α), the value of that ratio amongst households consuming at least q ($x_{2p}(q)/x_2(q)$), and the share of poor households amongst these households ($\pi_2(q)$). Looking at these parameters we see three categories of goods. First, rice, wheat and kerosene are necessity goods that poor households consume slightly less than rich households (α close to 1). Poor households are less likely than the non-poor to consume high levels of these goods ($\pi_2(q)$ is decreasing with q for rice and kerosene). When they do, they still tend to consume lower amounts on average than the non-poor ($\alpha_2(q)$ is decreasing with q for the three goods). The share of poor consumption in total consumption is high and falls particularly fast as we consider higher consumption levels for kerosene; this suggests kerosene may be a particularly good candidate for inclusion in a RSS from a redistribution perspective. Second, meat & 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. 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 consumed more by poor households than non-poor households on average, but the share of poor consumption in total consumption falls as we consider higher consumption 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 – an Engel curve that resembles that of an inferior

good at low levels of consumption and a normal good at higher levels.[24] Price and income elasticities presented 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 cereal types, as expected given the 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 & fish products and wheat, kerosene has a very low budget share.

IV. Welfare effects of ration shops in India

A. Main results

Table 4 presents baseline results. I focus in the text on welfare effects obtained for quota levels at the 10th, 25th and 50th percentiles of the distribution of consumption. These are the more relevant levels as quotas in India today are located between the 10th and 50th consumption percentiles of consumption for all goods. Expressions (3) and (5) however characterize the welfare effect of introducing a RSS for any potential quota level, in Figures A16 and A17 in the appendix I plot calibrated welfare effects for all quota levels. All welfare effects are expressed in money metric, are directly comparable across goods and multiplied by 100 to facilitate exposition. Using this metric introducing a non-distortive tax levying the same amount of income from all households would have a welfare effect of 0, and the most redistributive reform (taxing the non-poor to finance a transfer to the poor) would have a welfare effect of 77.5. [25]

The first panel of Table 4 reports the effect of introducing a ration shop system in a world without price risk - expression (3) above. This effect can only be positive if the RSS redistributes from the non-poor to the poor more than using the optimal linear rate and lump-sum transfers. It is positive for all quota levels considered for rice, kerosene and coarse cereals – the three goods consumed relatively more by the poor on average. Allowing for some-non linearity in the tax schedules on these three goods enables the government to achieve more redistribution by shielding part of poor households' consumption from this positive rate, whilst still raising revenues from richer households. The effects are particularly large for kerosene – at least three times those for rice at all quota levels, despite the fact that the poor consume more rice than kerosene relative to the average. 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,

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[24]In practice coarse cereals are necessity goods in states in which coarse cereals are staple goods but these states are poorer than the average, leading to $\alpha > 1$ at the all-India level.

[25]This assumes $\mu = g$, no behavioral responses to the taxes and transfers, and that all households face the average price. The welfare effect of a lump-sum tax of x units on all households is $100(\mu - \pi g_p - (1-\pi)g_{np}) = 0$ and the welfare effect of the redistributive policy is $100(g_p - g_{np})(1-\pi)x/x = 7.75$.

as seen in Table 3. Effects are negative or very small for the four goods with the lowest poor consumption share – pulses, sugar, meat & fish products and especially cooking gas. And finally it is positive for lower quota levels for wheat, which has an intermediate poor consumption share.

The second panel reports the added effect on welfare of introducing a ration shop system in a world with price risk – the insurance effect defined above. This effect is positive and increasing with the quota level, as expected: as the quota increases the RSS 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 ten 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 than, that for coarse cereals despite lower levels of price risk; this is because these goods represent a higher share of households' budget.

Finally the third panel presents the total effect in the presence of price risk – expression (5) above. The total welfare effect is always positive for kerosene, rice and coarse cereals, but the source of these positive effects is very 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. 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 effects are very small. 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 indicates that including cooking gas in the RSS is unambiguously welfare decreasing. I exclude cooking gas from graphical results in what follows for ease of exposition, no alternative calibration choices ever lead to positive welfare gains for this good.

Figure 4 explores the distribution of welfare effects for quota levels below median consumption levels in more detail.[26] The top graph considers how often ration shops have positive welfare effects when a random quota level is picked, 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.

Two types of results for subsamples of the population are of interest and pre-

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

sented in the appendix. First, welfare effects of introducing a RSS could vary across states because both household preferences (see Atkin, 2013) and poverty rates differ by state. Moreover, state governments have some discretion over which goods to sell in ration shops. I find that introducing a RSS is welfare-increasing for at least one cereal type in all states but that the cereal with the highest welfare effect differs across states, in line with different regional preferences (see Table A3).[27] Second, I find that calibrated welfare effects of introducing a RSS vary across urban and rural areas (see Figure A18 and Table A4). In particular the gains for kerosene are 25% larger in urban areas, reflecting the fact that kerosene is by far the main energy source for poor households in urban areas but less so in rural areas, where biofuels play a larger role (Khandker, Barnes and Samad, 2010).

B. *Robustness checks*

Calibration results are robust to allowing for a wide of range of plausible values for the calibration parameters.[28] In the appendix I consider alternative values for the price and income elasticities of demand which govern the efficiency effect of introducing a RSS: I first use the estimates obtained by Deaton, Parikh and Subramanian (1994) and then set the elasticities equal for all goods, biasing against then in favor of finding a positive welfare effect of ration shop systems. Results obtained when using this wide range of estimates are extremely similar, calibrated welfare effects for kerosene and cereals in particular are always within 10% of the baseline estimates (see Table A5). Calibration results are similarly robust to changes in how I measure the right-hand tail of the distribution of consumption, which could be measured with error if some households report abnormally high consumption values in the survey. It is reassuring to see that excluding households consuming more than the 99th or 95th percentile of consumption yields very similar results (see Table A6). I also consider welfare effects of introducing a RSS for the commodity most commonly consumed among the three good categories that aggregate different commodities, and find similar results: 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) – see Table A7. Taking into account households' home production of the good similarly does not affect results in a meaningful way, regardless of the method use to estimate households' production endowment – see Table A8.

There is more uncertainty regarding the values taken by other parameters in the expression for the welfare effect of introducing a RSS, either because of uncertainty regarding the real value of the parameter (coefficient of relative risk aversion) or because the parameters reflect normative judgments (government

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[27] This cereal is typically rice in the North East and South, coarse cereals in the West and wheat in the North.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.

[28] All the results in this section are presented and discussed in more detail in appendix A4.2.

preferences). The value taken by the coefficient of risk aversion affects results in a straightforward way: the insurance effect increases in the value of the risk aversion coefficient, the more so the higher the level of price risk. For small changes in the value of relative risk aversion relative to baseline (values between 1 and 4) results are essentially unchanged, one needs to use more extreme values to obtain meaningful changes (see Table A9).[29] Results are also similar when 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). Doubling the relative risk aversion coefficient of the poor and allowing for different levels of price risk for poor and non-poor households increases the welfare effect for the cereals slightly (by 1-4%) but leaves other effects unchanged.

To assess how results change with government preferences I vary the marginal social welfare weight of poor households, leaving that of the non-poor unchanged. Increasing poverty aversion increases the magnitude of the effects, as expected, but does not change the sign of the welfare effects or the ranking of effects across goods. Assuming the government values the marginal income of poor households four times more than that of the non-poor multiplies effects by roughly three compared to the baseline, assuming it only values it 50% more decreases the effects by around 50% (see Table A10). Finally I consider alternative classifications of households as poor or non-poor by increasing or decreasing the poverty line by 5, 10 or 20% (this varies the poverty headcount ratio substantially, 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 main results are unchanged. 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 (see Table A11).

Overall these results suggest that the magnitude of the welfare effects of introducing a ration shop system are driven by the relative distributions of consumption of each good for poor and non-poor households, not by the precise shape of the right-hand tail of these distributions or the values of the demand parameters. Changing government preferences changes the magnitude of the results in an intuitive way, but does not affect for which goods the welfare effects of ration shops are positive.

V. 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

[29]For example the insurance effects are of magnitude comparable to that of the redistribution effects for rice when the coefficient of relative risk aversion used is equal to 10.

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 (household expenditure being below the poverty line) in rural Karnataka.[30] They find that the correlation between statutory poverty status and actual poverty status is positive but very low. Using this estimate of the government's targeting capacity I find a decrease in the welfare effect of the RSS for all goods and all quota levels, as expected. Results show that the welfare effects 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 (see Table A12).[31]

The assumption of no administrative or corruption costs of implementing a ration shop system can similarly be relaxed. To assess how high these costs have to be to wipe out welfare gains from introducing a RSS 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 lump-sum transfer. I present results for different values of β in Table A13. I find that at a 3% relative 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 in the 5-8% range. This range rate is substantially lower than the estimated leakage rate of the RSS in India (Chakrabarti, Kishore and Roy, 2016, for example find a leakage rate of 38%) but note that these estimates include corruption and administrative costs that would likely occur for all types of government transfers, including lump-sum transfers, and hence cannot be directly compared to the β parameter used in the calibration.

The model also makes some assumptions regarding the supply side of the markets for commodities; these cannot easily be relaxed but merit discussion. I assume throughout that producer prices are exogenous and hence unaffected by the introduction of a ration shop system. This assumption may hold for small quotas and nonlinearities in the tax schedule, but is less likely to hold for India's current RSS parameters. The effect of ration shops on prices can be signed however as long as 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) and income effects are not too large: in this case we expect market prices to fall when a RSS is introduced, in line with empirical evidence for Mexico in Cunha, Giorgi and Jayachandran (2019). This would favor net-consumers at the expense of net producers and could increase the overall efficiency of markets under imperfect competition (see Coate, 1989).

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

[31]Simulations show that a RSS for wheat, coarse cereals, rice or kerosene is no longer welfare-increasing at any quota level when the government's targeting capacity is characterized by an inclusion rate that is, respectively, 23%, 31%, 34% and 38% higher than that under a universal transfer.

Relaxing this assumption 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.[32] Calibrating such a richer model would then require estimates of the general equilibrium effects of introducing a ration shop system on market prices. I leave considerations regarding the effect of ration shop systems on the supply side of markets to future research.

VI.   Conclusion

This paper shows that ration shop systems, a policy in place in many 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 improve social welfare by allowing the government to tax richer households relatively more than poorer households. I find that ration shops will yield largest welfare 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: 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 including cereals and kerosene in a ration shop system is welfare-improving compared to a situation in which the government uses (optimal) linear commodity taxes and a lump-sum transfers, under a wide range of household and government preference 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.

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[32]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.

REFERENCES

Ahmed, Akther, Agnes Quisumbing, Mahbuba Nasreen, John Hoddinott, and Elizabeth Bryan. 2009. "Comparing food and cash transfers to the ultra-poor in Bangladesh." IFPRI Research Monograph.

Alatas, Vivi, Abhijit Banerjee, Rema Hanna, Benjamin A Olken, and Julia Tobias. 2012. "Targeting the Poor: Evidence from a Field Experiment in Indonesia." *American Economic Review*, 102(4): 1206–1240.

Alderman, Harold. 2002. "Subsidies as a social safety net: effectiveness and challenges." The World Bank Social Protection Discussion Papers 25299.

Allen, Treb, and David Atkin. 2016. "Volatility and the Gains from Trade." National Bureau of Economic Research NBER Working Papers 22276.

Atkin, David. 2013. "Trade, Tastes, and Nutrition in India." *American Economic Review*, 103(5): 1629–1663.

Atkin, David, and Dave Donaldson. 2015. "Who's Getting Globalized? The Size and Implications of Intra-national Trade Costs." National Bureau of Economic Research NBER Working Papers 21439.

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

Atkinson, A B, and J E Stiglitz. 1980. *Lectures on Public Economics.* McGraw-Hill, New York.

Bachas, Pierre, and Mauricio Soto. 2017. "Not(ch) Your Average Tax System: Corporate Taxation Under Weak Enforcement." Mimeo, World Bank.

Balani, Sakshi. 2013. "Functioning of the Public Distribution System: An Analytical Report." PRS Legislative Research.

Banerjee, Abhijit, Rema Hanna, Jordan Kyle, Benjamin A. Olken, and Sudarno Sumarto. 2017. "Private Outsourcing and Competition: Subsidized Food Distribution in Indonesia." Mimeo, MIT.

Banerjee, Abhijit, Rema Hanna, Jordan Kyle, Benjamin A. Olken, and Sudarno Sumarto. 2018. "Tangible Information and Citizen Empowerment: Identification Cards and Food Subsidy Programs in Indonesia." *Journal of Political Economy*, 126(2): 451–491.

Bellemare, Marc F., Christopher B. Barrett, and David R. Just. 2013. "The Welfare Impacts of Commodity Price Volatility: Evidence from Rural Ethiopia." *American Journal of Agricultural Economics*, 95(4): 877–899.

Besley, Timothy, and Torsten Persson. 2013. "Taxation and Development." *Handbook of Public Economics*, 5: 51–110.

Besley, Timothy J, and S M Ravi Kanbur. 1988. "Food Subsidies and Poverty Alleviation." *Economic Journal*, 98(392): 701–719.

Best, Michael, Anne Brockmeyer, Henrik Jacobsen Kleven, Johannes Spinnewijn, and Mazhar Waseem. 2015. "Production vs Revenue Efficiency With Limited Tax Capacity: Theory and Evidence From Pakistan." *Journal of Political Economy*, 123(6).

Boadway, Robin, and Motohiro Sato. 2009. "Optimal Tax Design and Enforcement with an Informal Sector." *American Economic Journal: Economic Policy*, 1(1): 1–27.

Cage, Julia, and Lucie Gadenne. 2018. "Tax revenues and the fiscal cost of trade liberalization, 17922006." *Explorations in Economic History*, 70: 1 – 24.

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

Chakrabarti, Suman, Avinash Kishore, and Devesh Roy. 2016. "Entitlement fetching or snatching? Effects of arbitrage on India's public distribution system." International Food Policy Research Institute (IFPRI) IFPRI discussion papers 1588.

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

Coady, David, Margaret Grosh, and John Hoddinott. 2004. *Targeting of Transfers in Developing Countries: Review of Lessons and Experience.* The World Bank.

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

Coate, Stephen, Stephen Johnson, and Richard Zeckhauser. 1994. "Pecuniary redistribution through in-kind programs." *Journal of Public Economics*, 55(1): 19–40.

Cunha, Jesse M. 2014. "Testing Paternalism: Cash versus In-Kind Transfers." *American Economic Journal: Applied Economics*, 6(2): 195–230.

Cunha, Jesse M., Giacomo De Giorgi, and Seema Jayachandran. 2019. "The Price Effects of Cash Versus In-Kind Transfers." *Review of Economic Studies*, 86(1).

Currie, Janet, and Firouz Gahvari. 2008. "Transfers in Cash and In-Kind: Theory Meets the Data." *Journal of Economic Literature*, 46(2): 333–383.

Deaton, A., K. Parikh, and S. Subramanian. 1994. "Food Demand Pattern and Pricing Policy in Maharashtra: An Analysis Using Household Level Survey Data." *Sarvekshana*, 17(4): 11–34.

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

Dercon, Stefan, and Pramila Krishan. 2004. "Insurance Against Poverty." , ed. Stefan Dercon, Chapter Food Aid and Informal Insurance. Oxford University Press.

Dharmapala, Dhammika, Joel Slemrod, and John Douglas Wilson. 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, Peter A. 1975. "A many-person Ramsey tax rule." *Journal of Public Economics*, 4(4): 335–342.

Dreze, Jean, Reetika Khera, and Jessica Pudussery. 2015. "Food Security." *Economic and Political Weekly*, Vol. 50(Issue No. 34).

Emran, M Shahe, and Joseph E Stiglitz. 2005. "On Selective Indirect Tax Reform in Developing Countries." *Journal of Public Economics*, 89(4): 599–623.

Fackler, Paul L, and Barry Kent Goodwin. 2001. "Spatial price analysis." In *Handbook of Agricultural Economics*. Vol. 1, Part 2. 1 ed., , ed. B L Gardner and G C Rausser, Chapter 17, 971–1024. Elsevier.

Farrar, Curtis. 2000. "A Review of Food Subsidy Research at IFPRI." IFPRI.

Gordon, Roger, and Wei Li. 2009. "Tax Structures in Developing Countries: Many Puzzles and a Possible Explanation." *Journal of Public Economics*, 93(7-8): 855–866.

Gundimeda, Haripriya, and Gunnar Kohlin. 2006. "Fuel Demand Elasticities for Energy and Environmental Policies Indian Sample Survey Evidence." East Asian Bureau of Economic Research Energy Working Papers 22501.

Himanshu, Abhijit Sen. 2013. "In-Kind Food Transfers ? I Impact on Poverty." *Economic and Political Weekly*, Vol XLVI.

Hoynes, Hilary, Diane Whitmore Schanzenbach, and Douglas Almond. 2016. "Long-Run Impacts of Childhood Access to the Safety Net." *American Economic Review*, 106(4): 903–34.

IISD. 2014. "Subsidies to Liquefied Petroleum Gas in India: An overview of recent reforms." International Institute for Sustainable Development,.

Jansen, G, and S Malki. 2010. "Managing Food price inflation in South Asis." , ed. S. Ahmed and H. Jansen, Chapter Managing food price inflation in Pakistan. The University Press Limited.

Jensen, Anders. 2019. "Employment Structure and the Rise of the Modern Tax System." National Bureau of Economic Research, Inc NBER Working Papers 25502.

Khandker, Shahidur R., Douglas F. Barnes, and Hussain A. Samad. 2010. "Energy poverty in rural and urban India : are the energy poor also income poor ?" Policy Research Working Paper WPS 5463, World Bank.

Khera, Reetika, and Jean Dreze. 2011. "Trends in Diversion of Grain from the Public Distribution System." *Economic and P*, 45.

Khera, Reetika, and Jean Dreze. 2013. "Rural Poverty and the Public Distribution System." *Economic and*, Vol - XLVI.

Khullar. 2017. "Demand for Grants 2017-18 Analysis: Food and Public Distribution." PRS Legislative Research.

Kleven, Henrik Jacobsen, Camille Landais, and Emmanuel Saez. 2013. "Taxation and International Migration of Superstars: Evidence from the European Football Market." *American Economic Review*, 103(5): 1892–1924.

Kleven, Henrik Jacobsen, Claus Thustrup Kreiner, and Emmanuel Saez. 2016. "Why Can Modern Governments Tax So Much? An Agency Model of Firms as Fiscal Intermediaries." *Economica*, 83(330): 219–246.

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

Maskin, Eric, and John Riley. 1984. "Monopoly with Incomplete Information." *RAND Journal of Economics*, 15(2): 171–196.

Meran, Georg, and Christian von Hirschhausen. 2017. "Increasing Block Tariffs in the Water Sector – An Interpretation in Terms of Social Preferences." *The B.E. Journal of Economic Analysis & Policy*, 17.

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

Nagavarapu, Sriniketh, and Sheetal Sekhri. 2014. "Informal Monitoring and Enforcement Mechanisms in Public Service Delivery: Evidence from the Public Distribution System in India." Mimeo, Brown University.

Nichols, Albert L, and Richard J Zeckhauser. 1982. "Targeting Transfers through Restrictions on Recipients." *American Economic Review*, 72(2): 372–377.

Niehaus, Paul, Antonia Atanassova, Marianne Bertrand, and Sendhil Mullainathan. 2013. "Targeting with Agents." *American Economic Journal: Economic Policy*, 5(1): 206–238.

Olken, Benjamin A, and Monica Singhal. 2011. "Informal Taxation." *American Economic Journal: Applied Economics*, 3 (4)(15221): 1–28.

Piketty, Thomas, and Nancy Qian. 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." Government of India.

Pomeranz, Dina. 2015. "No Taxation without Information: Deterrence and Self-Enforcement in the Value Added Tax." *American Economic Review*, 105(8): 2539–2569.

Ramsey, F P. 1927. "A Contribution to the Theory of Taxation." *The Economic Journal*, 37: 47–61.

Rogers, Beatrice Lorge, and Jennifer Coates. 2002. "Food-Based Safety Nets and Related Programs." Friedman School of Nutrition Science and Policy Working Papers in Food Policy and Nutrition 12.

Saez, Emmanuel. 2001. "Using Elasticities to Derive Optimal Income Tax Rates." *Review of Economic Studies*, 68(1): 205–229.

Sahn, David E. 1987. "Changes in the Living Standards of the Poor in Sri Lanka During a Period of Macroeconomic Restructuring." *World Developmient*, 15: 809–830.

Scheuer, Florian, and Ivn Werning. 2018. "Mirrlees meets Diamond-Mirrlees." CEPR Discussion Papers 11172.

Sharkey, William W., and David S. Sibley. 1993. "Optimal non-linear pricing with regulatory preference over customer type." *Journal of Public Economics*, 50(2): 197–229.

Sheshinski, E. 1989. "Note on the Shape of the Optimum Income Tax Schedule." *Journal of Public Economics*, 40.

Slemrod, Joel, Shlomo Yitzhaki, Joram Mayshar, and Michael Lundholm. 1994. "The optimal two-bracket linear income tax." *Journal of Public Economics*, 53(2): 269–290.

Sukhtankar, Sandeep, Karthik Muralidharan, and Paul Niehaus. 2011. "Assessing the Scope for Cash Transfers in lieu of the TPDS in Rural and Urban Bihar." JPAL South Asia.

Tarozzi, Alessandro. 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, Stephen, Hailt Shalit, and Andrew Schmitz. 1980. "Consumer's Surplus, Price Instability, and Consumer Welfare." *Econometrica*, 48(1): 135–152.

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

Ventura-Alfaro, Carmelita E., Juan P. Gutiérrez-Reyes, Stefano M. BertozziKenefick, and Natalia Caldés-Gómez. 2011. "Análisis de costo-eficiencia del programa de apoyo alimentario en México." *Revista de Salud Publica*.

Weitzman, Martin. 1974. "Prices vs. Quantities." *Review of Economic Studies*, 41(4): 477–491.

Weitzman, Martin L. 1977. "Is the Price System or Rationing More Effective in Getting a Commodity to Those Who Need It Most?" *Bell Journal of Economics*, 8(2): 517–524.

World Bank. 2012. "Raskin subsidized delivery, Social assistance program and public expenditure review." 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
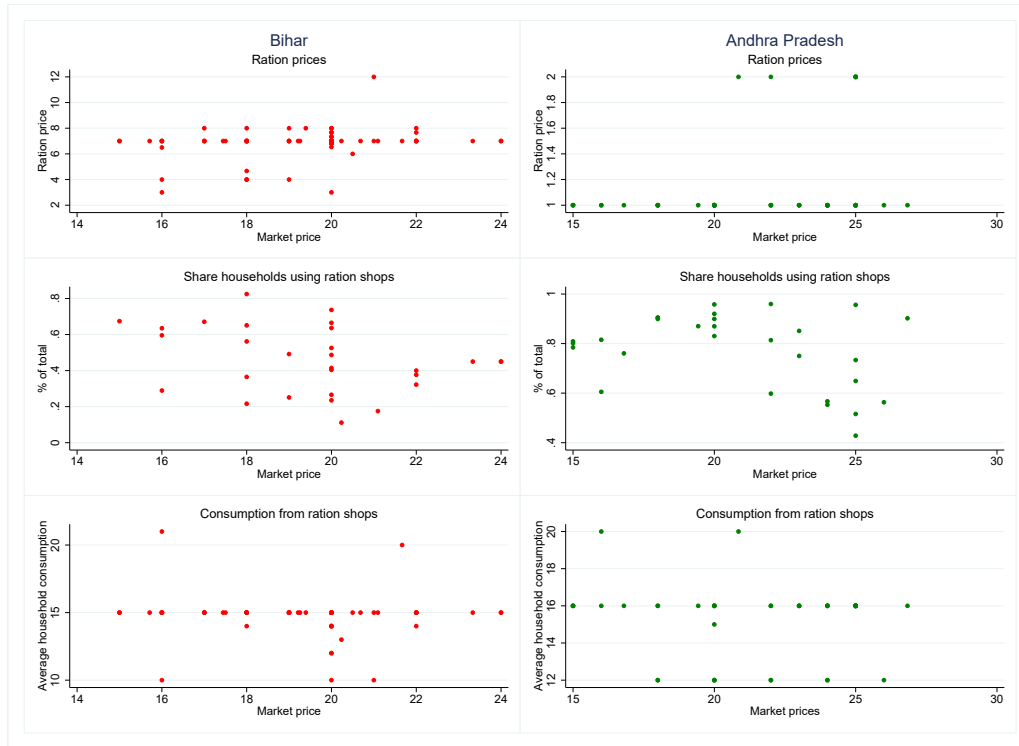
These graphs present the correlation between on the x-axis median market prices and on the y-axis i) median ration prices, ii) share of households using the RSS and iii) average consumption from ration shops, when positive. Each point represents a value for a sub-district, defined as the rural or urban part of a district. Unit values are used as a proxy for prices which are in INR per kilo and deflated using the mean all-India value of the price of the good in each quarter, with the last quarter (second quarter of 2012) used as the reference. 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 of households using the RSS) 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
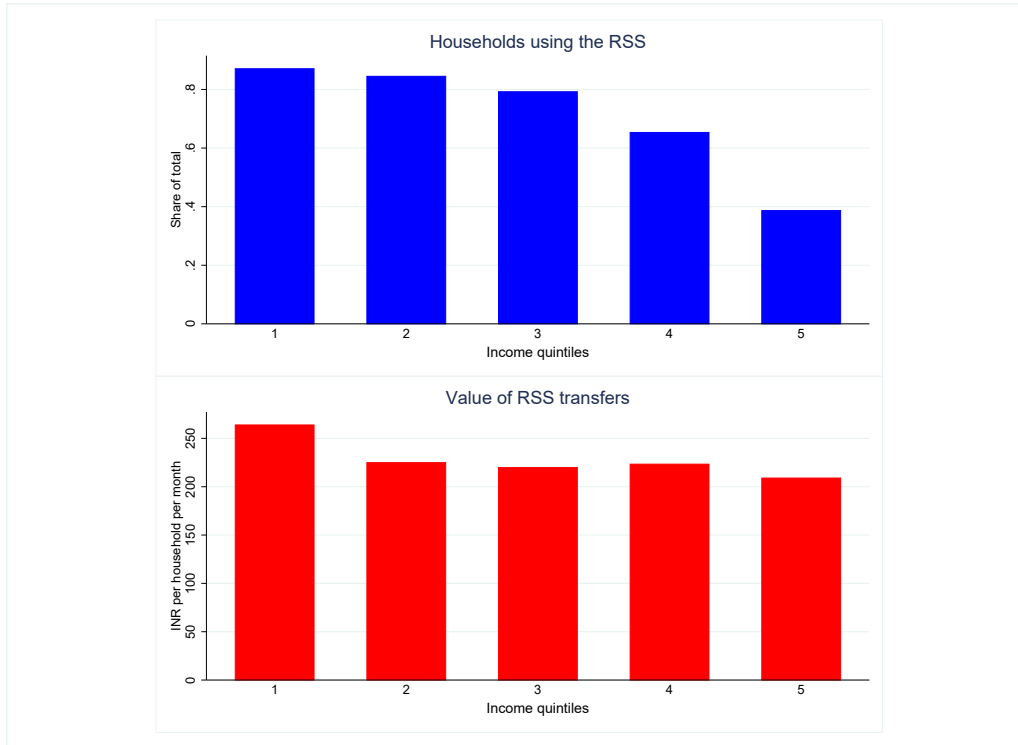
Each graph plots the distribution of a variable by quintile of household total expenditure per capita. The top graph plots the share of households that use the RSS, the bottom graph the value of RSS transfers conditional on using the RSS. Applying state-level poverty lines 22% of the population is categorized 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. BUDGET SET UNDER A RATION SHOP SYSTEM
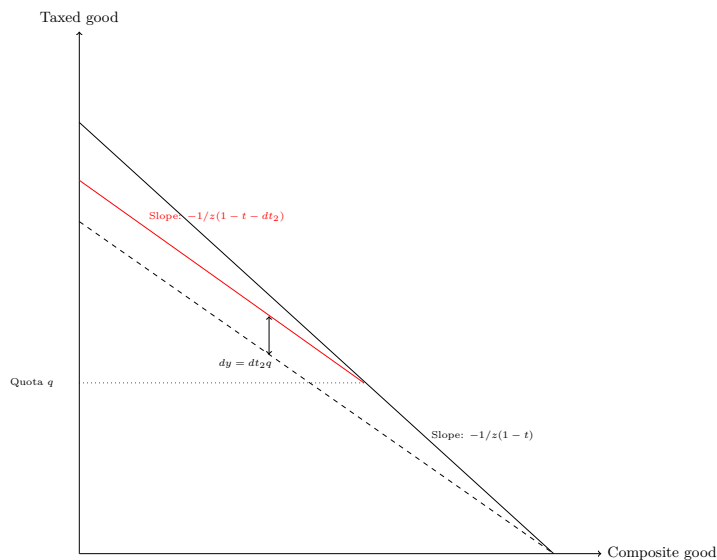
This graph plots a household's budget set under a linear tax and a ration shop system. The y-axis plots the quantity of the taxed good that can be purchased, the x-axis the quantity of the composite good. The black line represents the budget set under a linear tax. The red line represents the change in the budget set when a ration shop system is introduced in the form of an increase in the tax dt_2 on consumption amounts above the quota level q. This change can be decomposed in two steps: i) an uncompensated increase in the tax of dt_2, which leads to the budget set depicted by a dashed line, ii) an increase in the household's virtual income by dt_2q if she consumes at least q.

FIGURE 4. WELFARE EFFECT OF RATIONS SHOP SYSTEMS: ADDITIONAL RESULTS
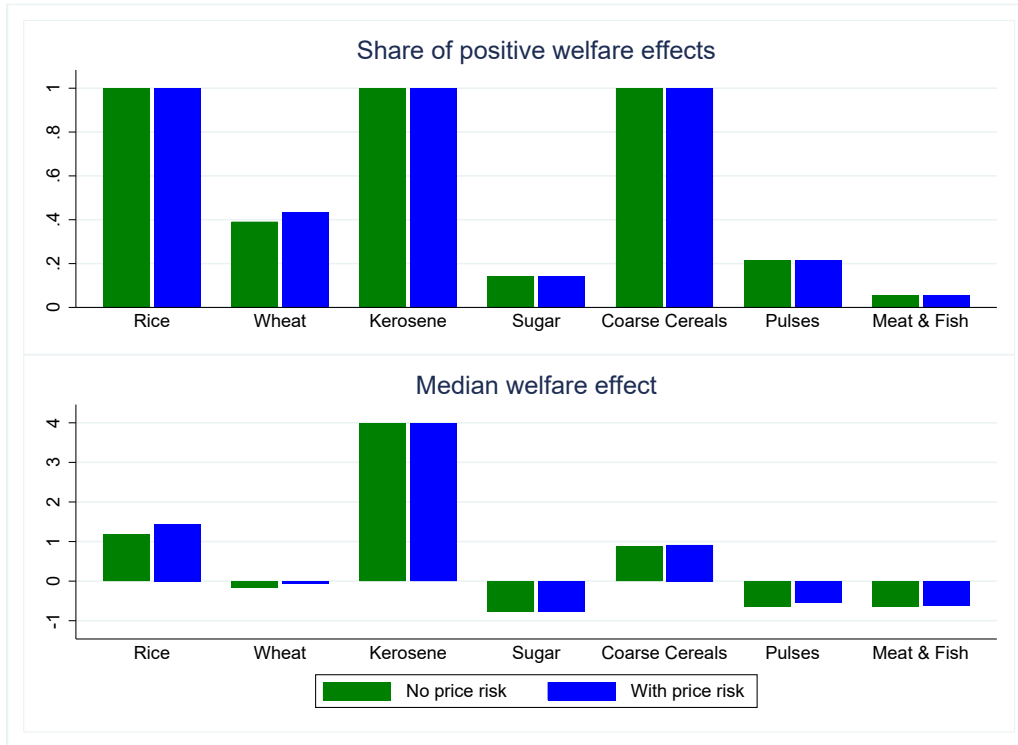
The top panel presents the share of quotas below the median total consumption levels for which the welfare effect of introducing a RSS is positive. The second panel presents the median welfare effect of introducing a RSS across quota levels, units are utils of the same social welfare function for all goods. The green bars correspond to the welfare effect in a world without price risk - expression (3) - and the blue bars correspond to the total welfare effect in a world with price risk - expression (5). The welfare effects are measured in 100 INR per INR raised.

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)	3.5 (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. In Panel C unit values are used as a proxy for prices which are in INR per kilo and deflated using the mean all-India value of the price of the good in each quarter, with the last quarter (second quarter of 2012) used as the reference. 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
Distribution of consumption levels					
α		0.96	0.83	0.93	0.66
$x_{2p}(q)/x_2(q)$	-10th pctile	0.97	0.94	0.75	0.72
	-25th pctile	0.94	0.92	0.76	0.78
	-50th pctile	0.95	0.89	0.74	0.82
π		0.22	0.22	0.22	0.22
$\pi_2(q)$	-10th pctile	0.22	0.19	0.27	0.19
	-25th pctile	0.21	0.19	0.25	0.15
	-50th pctile	0.20	0.20	0.22	0.11
$\theta(q)$	-10th pctile	9.49	10.29	4.3	3.17
	-25th pctile	3.07	4.61	3.1	2.12
	-50th pctile	1.67	1.82	2.4	1.68
Demand parameters					
ϵ		-0.2	-0.3	-0.5	-0.3
η		0.02	0.08	0.7	0.06
Price risk					
$\sigma(\%)$		6.66	6.52	6.46	2.74
Budget shares					
$s(\%)$	All	9.48 (5.97)	4.78 (2.95)	1.53 (1.59)	1.88 (0.68)
$s(\%)$	Poor only	15.6 (10.28)	7.97 (5.16)	2.39 (2.72)	3.37 (1.65)

		Meat & fish	Coarse cereals	Pulses	Cooking gas
Distribution of consumption levels					
α		0.48	1.03	0.68	0.17
$x_{2p}(q)/x_2(q)$	-10th pctile	0.56	1.05	0.74	0.69
	-25th pctile	0.61	1.02	0.76	0.75
	-50th pctile	0.69	1.00	0.82	0.80
π		0.22	0.22	0.22	0.22
$\pi_2(q)$	-10th pctile	0.18	0.22	0.19	0.05
	-25th pctile	0.15	0.22	0.17	0.04
	-50th pctile	0.10	0.21	0.11	0.02
$\theta(q)$	-10th pctile	4.86	8.62	2.65	2.89
	-25th pctile	3.28	4.2	1.94	1.79
	-50th pctile	2.27	2.5	1.6	1.44
Demand parameters					
ϵ		-0.8	-0.2	-0.4	-0.5
η		0.7	-0.1	0.2	0.7
Price risk					
$\sigma(\%)$		4.29	7.05	5.63	3.54
Budget shares					
$s(\%)$	All	5.34 (2.73)	2.81 (2.46)	3.47 (1.03)	3.76 (1.01)
$s(\%)$	Poor only	7.40 (3.78)	4.28 (3.53)	5.81 (2.60)	8.2 (3.4)

Each variable corresponds to a parameter in the model: α is the ratio of poor households' consumption to average consumption, $x_{2p}(q)/x_2(q)$ is the same ratio among households consuming at least the quota amount q, $\pi_2(q)$ the share of poor households among 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 uncompensated 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) amongst households purchasing positive amounts. 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

Quota (Consumption percentile)	10	25	50
Redistribution effect			
Rice	0.86	1.04	1.99
Wheat	0.57	0.21	-0.98
Kerosene	2.53	3.86	6.17
Sugar	0.11	-0.93	-2.91
Coarse cereals	0.90	0.86	0.99
Pulses	0.063	-0.95	-2.31
Meat & fish	-0.030	-0.65	-2.24
Cooking gas	-8.22	-20.0	-37.0
Insurance effect			
Rice	0.038	0.19	0.84
Wheat	0.012	0.040	0.24
Kerosene	0	0.010	0.020
Sugar	0	0.010	0.010
Coarse cereals	0.010	0.030	0.080
Pulses	0.050	0.090	0.20
Meat & fish	0.011	0.020	0.050
Cooking gas	0.020	0.052	0.11
Total effect			
Rice	0.90	1.23	2.83
Wheat	0.58	0.24	-0.74
Kerosene	2.53	3.87	6.18
Sugar	0.11	-0.92	-2.90
Coarse cereals	0.91	0.89	1.07
Pulses	0.11	-0.86	-2.11
Meat & fish	-0.020	-0.63	-2.19
Cooking gas	-8.20	-20.0	-36.9

The first panel presents the welfare effect of introducing a RSS in a world without price risk (expression (3)) at quota levels equal to the 10th, 25th or 50th percentiles of the total distribution of consumption for the good. The middle panel presents the insurance effect of introducing a RSS in a world with price risk as defined in the text, and the last panel presents the sum of the two effects (expression (5)). The welfare effects are measured in 100 INR per INR raised. See the text for the description of the method and data used.