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Can Rationing Increase Welfare? Theory and an Application to India's Ration Shop System[†]

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In many developing countries, households can purchase limited quantities of goods 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. (*JEL* D12, H23, H25, O12)

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 percent of the world's population. They have, however, attracted little attention in the literature (with some exceptions; see, for example, Tarozzi 2005; Cunha, De Giorgi, and Jayachandran 2019). Table 1 presents a nonexhaustive 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 subsidizing 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 piecewise 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

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

Table 1—Ration Shop Systems around the World: Some Examples

Country	Program name	Eligibility	Goods	Cost/scope	Source
Bangladesh	Vulnerable group feeding	Targeted	Food grains	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 until 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	US$750 million in 2007/2008	Jansen and Malki (2010)
Sri Lanka	Food stamps	Universal until 1979, targeted since	Rice, flour, sugar	5% of GDP (in the 1980s)	Farrar (2000), Sahn (1987)

Notes: I categorize any program that sells household 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, and "targeted" means the government restricts access (at least in theory) to households that meet some criteria.

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 (piecewise 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, underdeveloped retail markets, and regional trade regulations lead to poor

[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, 427).

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 covary 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 an 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, this holds 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 an 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 an 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 observed easily 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 nonpoor than poor households—so there are clear redistributive gains from allowing them to be sold in an RSS. In addition, there are substantial insurance gains from using an 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 an 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 the vouchers 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 an RSS; calibration results suggest these gains are wiped out in the Indian context when institutional leakages are 5–8 percent 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, De 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 generally 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 an 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, Muralidharan, Niehaus, and Sukhtankar 2020; Banerjee et al. 2017, 2018) or studies the effect of

recent changes in India's ration shop systems (Drèze and Khera 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, nontaxable 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 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 subgoods. The question asked in this paper is also related to Weitzman (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 I describes India's ration shop system, focusing on key characteristics that are building blocks of the model. Section II sets up the model and derives conditions under which a ration shop system is welfare improving. Section III explains the methodology and data used to calibrate these expressions numerically for India. Section IV presents the results, and Section V discusses their robustness to relaxing some of the model's key assumptions.

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

[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.

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, 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 II.

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 percent of GDP) and reach: 70 percent of Indian households use ration shops (PRS Legislative Research 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 Aadhaar ID system, which was rolled out in India in the early 2010s and enables government services (including ration shops) to identify uniquely individuals using their fingerprints and iris scans. Households' ration entitlements, past ration purchases, and the 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 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, Pudussery, and Khera 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 online Appendix Section A2 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

[5] Until 2017, it was thus not possible 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 possible by the Aadhar-linked ePDS system, which only authorizes ration shop staff to sell to a household if that household has not already purchased its ration this month.

Table 2—Goods Sold through the Ration Shop System: Descriptive Statistics

	Rice	Wheat	Kerosene	Sugar
Panel A. Parameters of the system (*source: State laws*)				
Official quota (kg or liters per month)	5–25	5–25	2–5	0.5–2
Official ration price (rupees)	0–9	1–9	13–17	12–16
Panel B. Household consumption by source, kg or liters 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 percentile	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
Percent consume from all sources	97	91	76	98
Percent consume from ration shops	39	30	64	29
Percent consume from home production	15	14	0	0
Panel C. Prices, rupees (*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 percentile	14–30	10–28	20–38	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 percentile	1–7	2–10	14–17	13–17
			Poor households	Nonpoor households
Panel D. Total consumption from ration shops (*source: Survey data*)				
Percent use ration shops			84.6	66.5
Ration value (rupees)–mean (standard deviation)			272.6 (216)	216.9 (213)
Ration value (percent total expenditure)–mean (standard deviation)			9.2 (9.1)	4.1 (4.9)

Notes: Consumption is per month and measured at the household level; prices are in rupees and quantities in kilos (rice, wheat, and sugar) or liters (kerosene). Descriptive statistics for each variable are for households with nonzero value of this variable except for "Percent 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 rupees 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 sources used in panel A are state laws, available from each state's website. See online Appendix A2 for detailed parameters in each state and data sources. The source used for panels B to D is the National Sample Survey Organization (NSSO) consumption survey for 2011–2012; consumption and prices are as reported by households. In panel D, households are classified as poor and nonpoor using state-level official poverty lines. See the text for a description of the data used and the online 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.

between the twenty-fifth and fiftieth percentiles of the distribution of consumption from all sources for rice, wheat, and kerosene and under the twenty-fifth 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 twenty-fifth 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 online Appendix Section A2 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 covaried 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 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 perfect implementation in modeling 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 online 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 percent 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 characteristic 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 nonpoor 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 nonpoor households report using the RSS, but there is some targeting of subsidies: among households using ration shops, the monetary value of transfers is 20 percent higher for the poor than the nonpoor. Figure 2 shows that this limited targeting is not only due to mistargeting close to the poverty line, set at the twenty-second percentile of the distribution: 65 percent 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 nonpoor households less generous entitlements (lower quotas or higher ration prices).[6] Overall, Indian

[6]There could also be de facto targeting of the RSS even if all households were equally eligible to use ration shops if nonpoor households chose not to use them, because the goods sold in ration shops are imperfect substitutes for those sold on the market. In online Appendix A2, I consider the extent to which states are capable of targeting

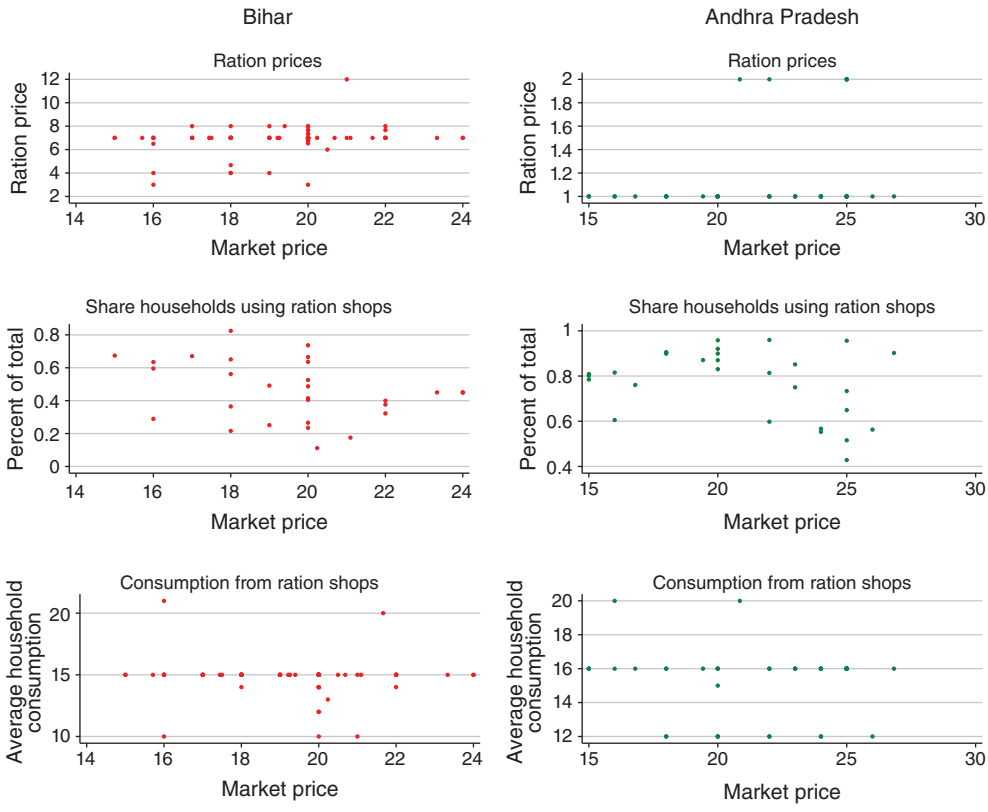

Figure 1. District-Level Correlations between Market Prices and RSS Characteristics for Rice

Notes: 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 subdistrict, defined as the rural or urban part of a district. Unit values are used as a proxy for prices, which are in rupeess 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 percent 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 percent 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.

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 (Gentilini, Honorati, and Yemtsov 2014). I assume no government targeting capacity in the baseline model below and relax this assumption in an extension.

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 percent 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 nonpoor from using it. There is moreover no clear evidence of better targeting among states with very different entitlements for the poor and nonpoor.

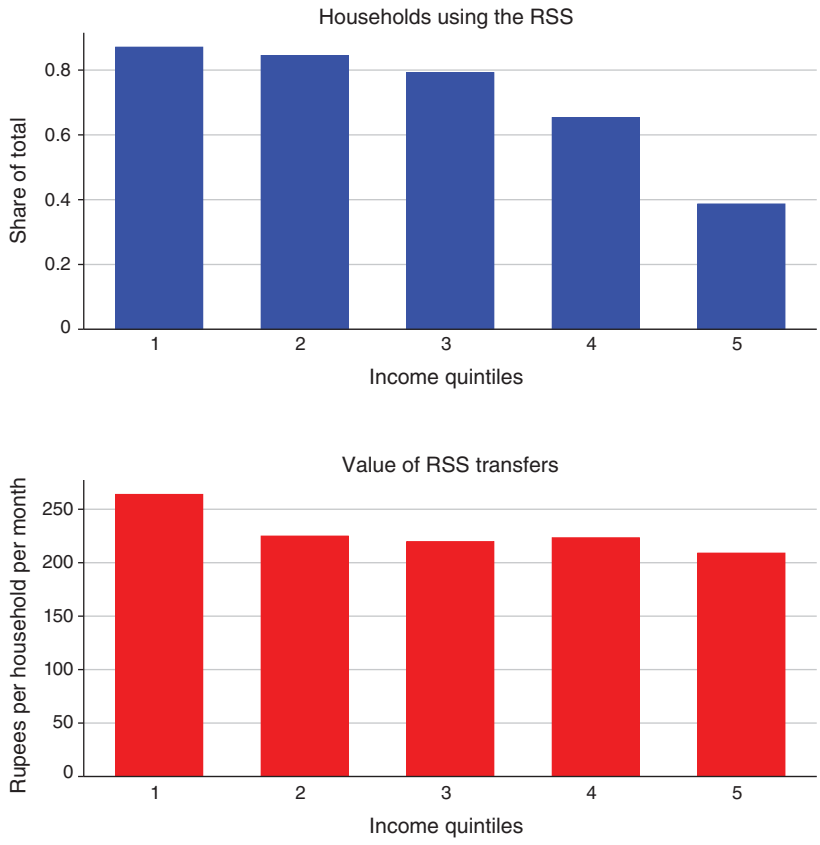

FIGURE 2. USE OF RATION SHOP SYSTEM BY INCOME QUINTILE

Notes: 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 percent of the population is categorized as poor, so most households in the top 4 quintiles are nonpoor. 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.

A final question of interest is the extent to which households arbitrage: the difference between the ration and market prices generates an incentive to resell quotas on the market. This question affects how we think about ration shop systems as a redistribution instrument: in a situation with costless resale, the ration shop system essentially transfers the same amount to all households and is equivalent to a lump-sum transfer (Besley and Kanbur 1988). There are no data available on resale of quotas, but information on how much households consume from the ration shops enables me to assess the ease with which households could resell in this context: if resale were costless, we would see that all households would choose to purchase their total quota amount in order to resell the amounts they are not consuming on the market. Online 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 percent of households for rice, 11 percent for sugar, and 33 percent for kerosene. The evidence suggests that resale must be costly as a nonnegligible share of households choose not to resell (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 resale. I discuss the impact of relaxing these assumptions at the end of the model section. I introduce varying market prices in Section IIC.

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 online 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 piecewise and increasing. I assume the government cannot implement piecewise 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

[7] The government needs full knowledge of each household's consumption of the good to implement piecewise 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 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 identifies uniquely households.

A. *Setup*

There is a continuum of mass 1 of households i that differ in their exogenous income y_i and preferences characterized by utility function $u_i(\cdot)$. 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}, its uncompensated price elasticity of demand, and η_{ik}, its income elasticity of demand. I write $v_i(\cdot)$ the household's indirect utility function, s_i^k the budget share it spends on good k, and $p^k\left(x_i^k\right)$ the tax-inclusive price of k; households maximize utility subject to a standard budget constraint $\sum_k x_i^k p^k\left(x_i^k\right) \leq y_i$. 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 online 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 consumption of the good, and equilibrium consumption x_i is given by

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

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 $G(\cdot)$, 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:

$$W = \int_i G\left(v_i(p, y_i)\right) di + \mu t \int_i x_i di. \tag{1}$$

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 an 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 (nondistortive) transfer. I assume in what follows the government only cares about whether a household is poor or nonpoor and define g_p (g_{np}) the social value of one extra unit of income to a poor (nonpoor) 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

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

where $\epsilon = \int_i \epsilon_i x_i di / \int_i x_i di$ is the weighted average uncompensated elasticity of demand, and $\alpha = \int_{i \in P} x_i di / \left(\pi \int_i x_i di\right)$ is the ratio of average consumption of poor households to average consumption of all households.[9] Equation (2) is Diamond's (1975) 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 online 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.

[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 online Appendix presents results obtained using more general government preferences imposing only that $\partial g_i / \partial y_i \leq 0$; all results are qualitatively unchanged.

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

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

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

where the subscript 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* $\theta(q) = x_2(q)/q > 1$ *is a scale parameter measuring the thickness of the right-hand side of the distribution of the good.*

PROOF:

See online 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 an 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 an RSS on households consuming at least q can be decomposed into two parts, depicted in Figure 3. First, there is 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 $dt_2 q$, which partially compensates for the increase in price; this shifts the budget constraint outward. This decreases their 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.

On the contrary, the efficiency effect will 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

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

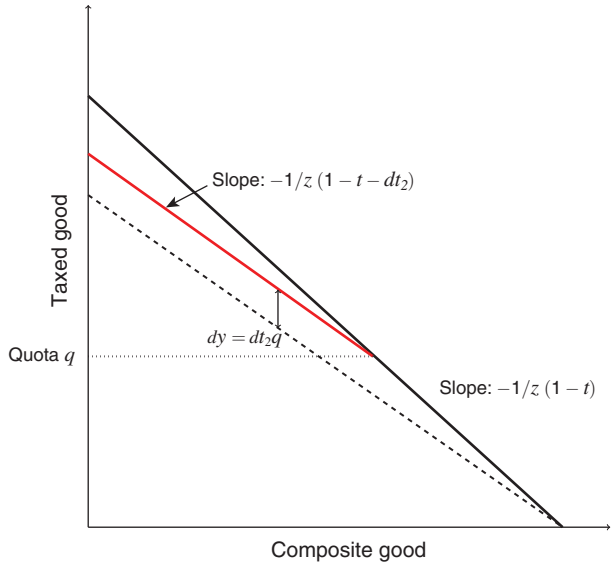

FIGURE 3. BUDGET SET UNDER A RATION SHOP SYSTEM

Notes: 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 plots 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, and (ii) an increase in the household's virtual income by $dt_2 q$ if it consumes at least q.

with high demand are also substantially less price elastic than the average, introducing an RSS shifts the burden of taxation toward 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 an RSS unless the price elasticity of demand is strongly decreasing with consumption: for this government, $\left(g_p - g_{np}\right) = 0$ and the optimal linear rate is positive, so the effect of introducing an RSS is negative unless demand elasticities are very heterogeneous.[11]

Unless preference heterogeneity takes a very specific form, introducing an 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 nonpoor; it is a function of the relative distribution of consumption among these two groups of households and the strength of the government's redistributive

[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 its 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 piecewise *decreasing* tax schedule.

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

preferences $(g_p - g_{np})$. Introducing an 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 an 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 dtx_i. An RSS on the other hand increases the taxes paid by households consuming at least q by an 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, i.e., as long as consumption of the good is increasing with income.

The total welfare effect of introducing an 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 $\left(x_{2p}(q)/x_2(q)\right)$, 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 nonpoor, 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 an 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 households consume more than the nonpoor on average $(\alpha > 1)$ as long as the nonpoor 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 nonpoor consume but in high amounts and that

[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 an RSS is maximized when the optimal tax rate on consumption below q is lowest compared to the optimal tax rate above q, i.e., when consumption below the quota is an inferior good whilst consumption above the quota is a luxury good. Commodities with such highly nonmonotone Engel curves are, in practice, uncommon; among the set of commodities with monotone Engel curves, necessity goods best approximate this scenario.

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 an RSS enables the government to redistribute more than simply using a linear tax, by taxing the nonpoor without taxing the poor. In most cases, this redistribution gain comes at an efficiency cost due to the fact that introducing an RSS further distorts prices away from the first-best. Which effect dominates is a function of the relative distribution of consumption among the poor and the nonpoor, 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 underdeveloped 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 (an RSS only assumes the government observes the average price $\bar{z}$).

Introducing a ration shop system is now equivalent to introducing both a piecewise 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

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

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]

[14] In what follows, I assume that demand parameters ϵ, r, and η are homogeneous 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).

The optimal linear commodity tax rate is therefore increasing in the level of price risk (see online Appendix for a proof). Intuitively, this is because a commodity tax 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 piecewise 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 $g_i\left[s_i(r-\eta)-\epsilon\right]-\mu\epsilon$, 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*

$$
\begin{aligned}
(5)\quad dW^P(q) \;=\; & \mu\frac{t^{**}}{\bar{z}+t^{**}}\left(\frac{\epsilon_2^c(q)}{\theta-1}-\epsilon+\epsilon_2(q)\right)\\
& +\left(g_p-g_{np}\right)\left(\pi\alpha-\pi_2(q)\frac{x_{2p}(q)-q}{x_2(q)-q}\right)+\frac{\sigma^2}{\left(x_2(q)-q\right)\left(1-H(q)\right)}\\
& \times\Bigg[-\epsilon(r-\eta)\int_{x_i\geq q}g_i x_i s_i\,di\\
& \quad +(\bar{z}+t)(r-\eta)\left(\int_{x_i<q}g_i x_i s_i\,di+q\int_{x_i\geq q}g_i s_i\,di\right)\\
& \quad +\epsilon(\bar{z}+t)\int_{x_i<q}(g_i-\mu)x_i\,di\Bigg],
\end{aligned}
$$

where t^{**} *is the optimal linear rate adjusted for price risk, defined in the online 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 online Appendix A1.2. ∎

The first three lines of (5) represent the effect of introducing a piecewise increasing tax in the presence of price risk, which can be decomposed into three parts. The first is the efficiency effect, which is now a function of the optimal linear rate adjusted for price risk (first line), the second is the redistribution effect, unchanged from expression (3) above. The third part captures the insurance effect of increasing the tax on households consuming more than q, which is always positive. The last two lines represents the additional effect of introducing a price-stabilizing transfer. The first term reflects 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 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 an 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 reflect more closely the context of developing countries.[16] First, most developing countries can exclude some nonpoor households from receiving subsidies. In the online 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 nonpoor 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 an 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 $\left(1 + \beta\right)$ units, where $\beta > 0$ is the leakage

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

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 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 it 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 an 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 online Appendix 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 an RSS because the tax on one good affects 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, and 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 an RSS for one good when the price of all goods covary is therefore increasing in the correlation between the price of this good and the price of all other goods. Online 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 underestimates 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.

[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 Organization (National Sample Survey Organization 2012). The survey contains detailed information on all goods consumed over the last month by 120,000 households in 2011–2012 within the 20 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 and 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 nonnegligible share of the typical household's budget, making them potential candidates for inclusion in the RSS: 62 percent of households consumed meat and fish products in the last month, and 98 percent 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 an RSS for cooking gas (International Institute for Sustainable Development 2014). Including cooking gas in the calibration allows for an evaluation of the welfare effect of this policy change.

Households report for each good (i) their purchases from the ration shops, (ii) their market purchases, and (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 measure income directly. 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 nonpoor—the share of poor households (π in the model) in the population is 22.2 percent. 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]

[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 online Appendix.

[19] The survey reports households' consumption of each good from their home production but not how much they produce; see the online 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 an 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 Köhlin (2006) for kerosene.[21] Both Kumar et al. (2011) and Gundimeda and Köhlin (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 three 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 nonpoor households. Baseline results assume the government values an extra unit of income to the poor twice as much as that to the nonpoor ($g_p = 2$ 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 calibrated directly 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 an 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 defined uniformly 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 household surveys for the years 2002–2003 to 2011–2012. I define a market as the lowest geographical unit at which the surveys are representative in all years—the rural and urban parts of each of the 77 NSS regions (hereafter subregions). I deflate all unit

[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.

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-subregions 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 nonpoor households because they are more likely to live in remote rural areas. I therefore also measure price variations over time for poor and nonpoor households separately and discuss results obtained, allowing for these different levels of price risk. See online Appendix A4.3 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 tenth, twenty-fifth, and fiftieth 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 nonpoor 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 nonpoor $(\alpha_2(q)$ 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 an RSS from a redistribution perspective. Second, meat and fish products, pulses, sugar, and cooking gas are traditional normal goods: they are consumed substantially more by the nonpoor (α below two-thirds), and poor households are less likely than nonpoor 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 nonpoor 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 nonpoor households but in large amounts by those nonpoor 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 and fish products and kerosene.

Turning to determinants of the insurance effect of an RSS, we see that price risk is highest for the three cereal types as expected given the local nature of markets for

[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.

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 percentile	0.97	0.94	0.75	0.72
	-25th percentile	0.94	0.92	0.76	0.78
	-50th percentile	0.95	0.89	0.74	0.82
π		0.22	0.22	0.22	0.22
$\pi_2(q)$	-10th percentile	0.22	0.19	0.27	0.19
	-25th percentile	0.21	0.19	0.25	0.15
	-50th percentile	0.20	0.20	0.23	0.11
$\theta(q)$	-10th percentile	9.49	10.29	4.3	3.17
	-25th percentile	3.07	4.61	3.1	2.12
	-50th percentile	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					
σ (%)		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 and 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 percentile	0.56	1.05	0.74	0.69
	-25th percentile	0.61	1.02	0.76	0.75
	-50th percentile	0.69	1.00	0.82	0.80
π		0.22	0.22	0.22	0.22
$\pi_2(q)$	-10th percentile	0.18	0.22	0.19	0.05
	-25th percentile	0.15	0.22	0.17	0.04
	-50th percentile	0.10	0.21	0.11	0.02
$\theta(q)$	-10th percentile	4.86	8.62	2.65	2.89
	-25th percentile	3.28	4.2	1.94	1.79
	-50th percentile	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					
σ (%)		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	7.54 (3.78)	4.28 (3.53)	5.81 (2.60)	8.2 (3.4)

Notes: 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, and $\theta(q)$ total consumption above q divided by q. For each good, I consider values of q equal to the tenth, twenty-fifth, and fiftieth percentiles of the distribution of consumption. The terms ϵ and η are respectively uncompensated price and income elasticities, σ is the coefficient of variation of the price of the good, and 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.

cereals in India. It is lowest for sugar, a commodity whose production is less influenced by local weather conditions. Budget shares are large for rice and to a lesser extent for cooking gas, meat and fish products, and wheat; 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 tenth, twenty-fifth, and fiftieth percentiles of the distribution of consumption. These are the more relevant levels as quotas in India today are located between the tenth and fiftieth consumption percentiles of consumption for all goods. Expressions (3) and (5), however, characterize the welfare effect of introducing an RSS for any potential quota level. In Figures A16 and A17 in the online 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 nondistortive tax levying the same amount of income from all households would have a welfare effect of 0, and the most redistributive reform (taxing the nonpoor 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 nonpoor 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 nonlinearity 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, as seen in Table 3. Effects are negative or very small for the four goods with the lowest poor consumption share—pulses, sugar, meat and 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

[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 $100\big(\mu - \pi g_p - (1-\pi)g_{np}\big) = 0$, and the welfare effect of the redistributive policy is $100\big(g_p - g_{np}\big)(1-\pi)x/x = 7.75$.

TABLE 4—BASELINE RESULTS

Quota (consumption percentile)	10	25	50
Panel A. 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 and fish	−0.030	−0.65	−2.24
Cooking gas	−8.22	−20.0	−37.0
Panel B. 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 and fish	0.011	0.020	0.050
Cooking gas	0.020	0.052	0.11
Panel C. 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 and fish	−0.020	−0.63	−2.19
Cooking gas	−8.20	−20.0	−36.9

Notes: The first panel presents the welfare effect of introducing an RSS in a world without price risk (expression (3)) at quota levels equal to the tenth, twenty-fifth, or fiftieth percentiles of the total distribution of consumption for the good. The middle panel presents the insurance effect of introducing an 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 rupees per rupees raised. See the text for the description of the method and data used.

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, and kerosene has high price risk but a very low budget share. The insurance effects for meat and fish products and pulses are 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 of Table 4 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 percent of the total effect for rice and 3–8 percent 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 and 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 an 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 nonnegligible 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, and 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 and fish products, and pulses.

Two types of results for subsamples of the population are of interest and presented in the online Appendix. First, welfare effects of introducing an 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 an 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 an RSS vary across urban and rural areas (see Figure A18 and Table A4). In particular, the gains for kerosene are 25 percent 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 online Appendix, I consider alternative values for the price and income elasticities of demand which govern the efficiency effect of introducing an RSS: I first use the estimates obtained by Deaton, Parikh, and Subramanian (1994) and then set the elasticities equal for all goods, biasing

[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.

[27] This cereal is typically rice in the 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 online Appendix A5.2.

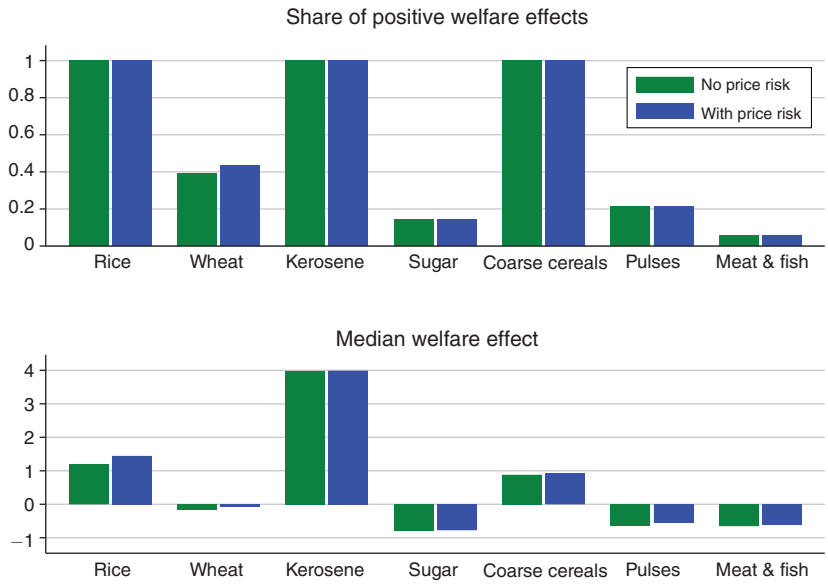

FIGURE 4. WELFARE EFFECT OF RATIONS SHOP SYSTEMS: ADDITIONAL RESULTS

Notes: The top panel presents the share of quotas below the median total consumption levels for which the welfare effect of introducing an RSS is positive. The second panel presents the median welfare effect of introducing an 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 rupees per rupees raised.

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 percent 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 ninety-ninth or ninety-fifth percentile of consumption yields very similar results (see Table A6). I also consider welfare effects of introducing an 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 and 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 used 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 an 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 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 nonpoor households are affected by price variations in the same way—poor households are much closer to subsistence levels of consumption than nonpoor 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 nonpoor households increases the welfare effect for the cereals slightly (by 1–4 percent) 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 nonpoor 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 nonpoor multiplies effects by roughly three compared to the baseline; assuming the government only values it 50 percent more decreases the effects by around 50 percent (see Table A10). Finally, I consider alternative classifications of households as poor or nonpoor by increasing or decreasing the poverty line by 5, 10, or 20 percent (this varies the poverty headcount ratio substantially, from 10 percent to 36 percent). Welfare effects of introducing an 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 isdriven by the relative distributions of consumption of each good for poor and nonpoor 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 an RSS will decrease if we allow for some targeting capacity in the form of a transfer that reaches the poor with probability $\hat{\pi} > \pi$. I use estimates of $\hat{\pi}$ from Niehaus et al. (2013), who measure households' statutory poverty status (possession of a state-issued below poverty line card) and actual poverty status (household expenditure being below the

[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 ten.

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 effect remains positive with targeting for low quota levels (tenth percentile) for rice, wheat, coarse cereals, and kerosene but becomes negative at the twenty-fifth 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 an 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 percent relative leakage rate, the welfare effect of an 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 percent 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 percent), 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 compared directly 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 be relaxed easily 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 an 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 an RSS is introduced, in line with empirical evidence for Mexico in Cunha, De 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). 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

[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 online Appendix.

[31] Simulations show that an 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 percent, 31 percent, 34 percent, and 38 percent higher than that under a universal transfer.

[32] In particular, an RSS system that 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.

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 nonnegligible 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 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 nonpoor households, at least until more efficient forms of redistribution are developed.

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