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Redistributive Policy Shocks and Monetary Policy with Heterogeneous Agents

Governments in EMDEs routinely intervene in agricultural markets to stabilize food prices in response to adverse shocks. Such interventions involve a large increase in the procurement and redistribution of agricultural output, which we refer to as a redistributive policy shock. What is the impact of a redistributive policy shock on inflation and the distribution of consumption among rich and poor households? We build a two-sector-two-agent NK-DSGE model and estimate it for India using Bayesian methods. We characterize optimal monetary policy and show that the welfare costs of redistributive policy shocks are significantly higher under nonoptimized rules.

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1. INTRODUCTION

GOVERNMENTS IN MANY EMERGING MARKET and developing economies (EMDEs) routinely intervene in their agricultural markets. Higher food

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security norms require an increase in the redistribution of agricultural output to the poorest population in a country. Other interventions involve the procurement and redistribution of food to minimize food price volatility in the wake of domestic (e.g., poor rainfall) or external (e.g., global commodity price) shocks.

There are many examples of these types of interventions. In 2013, India enacted a new National Food Security Act (NFSA) under the umbrella of a new "rights-based" approach to food security. The NFSA legally entitles "up to 75% of the rural population and 50% of the urban population to receive subsidized food grains" under a Targeted Public Distribution System. Under this new act, about two-thirds of the population is covered to receive highly subsidized food grains. The ostensible goal is to smooth the purchasing power of poor populations that are food insecure. Moreover, in India, the food entitlements under the NFSA were doubled during COVID and made completely free (see Ranade 2023).

In the Philippines, the National Food Authority (NFA) is mandated to purchase and distribute rice and other commodities across the country. In response to the rise in world prices of grains in the last quarter of 2007, the Philippine government provided higher funding support to implement its Economic Resiliency Program, part of which involved scaling up a rice production enhancement program called "Ginintuang Masaganang Ani." The total fiscal cost of the NFA rice subsidy jumped to 0.6% of GDP in 2008 compared to 0.08% of GDP in 2007 (Balisacan, Sombilla, and Dikitanan 2010). In Bangladesh, the government regularly intervenes in food markets to reduce price fluctuations and procure rice for safety net programs (Chowdhury et al. 2024, Hossain and Deb 2010). To ensure food security in Indonesia in 2008, the Indonesian government, through its BULOG operational strategy, doubled the amount of rice distributed to cover all poor families under the RASKIN program through targeted market operations requested by local governments. Regular rice distribution for the poor was achieved by increasing domestic rice procurement. BULOG's heavy procurement added to demand, helping farmers maintain prices at a profitable level (Saifullah 2010). The South Korean government also designs its agricultural policy for food security reasons based on self-sufficiency (Beghin, Bureau, and Park 2003).

Interventions such as the enactment of a new NFSA with wider coverage, the expansion of free or subsidized food entitlements during COVID, or surprise government interventions when there are large price shocks in food commodities, such as the world rice price crisis of 2008, have two salient features. First, they typically imply higher procurement and redistribution of food commodities by the government to households. This raises the food subsidy to the household. Second, such interventions are conducted at a relatively high frequency, that is, several times within a year. We refer to frequent interventions by the government in agriculture markets as redistributive policy shocks. The main research questions that this paper addresses are: how should monetary policy respond to redistributive policy shocks? What is the impact of redistributive policy shocks on the sectoral and aggregate dynamics of inflation and rich and poor consumption? What are the welfare costs of redistributive policy shocks and other shocks emanating from the agriculture sector? The novel part of our analysis is that we allow for government intervention in the agriculture market that captures the essence of procurement and redistributive style interventions in EMDEs.

We build a two-sector (agriculture and manufacturing) two-agent (rich and poor) New Keynesian DSGE model. We refer to this as 2S-TANK. Our theoretical model builds on earlier work by Aoki (2001), Debortoli and Galí (2024), and Ghate, Gupta, and Mallick (2018). The main methodological contribution of our framework is that we extend the two-agent New Keynesian, cthat is, TANK DSGE framework of Debortoli and Galí to two sectors (agriculture and manufacturing). On the production side, the agriculture sector is perfectly competitive with flexible prices, while the manufacturing sector is characterized by monopolistic competition and sticky prices. As in Debortoli and Galí, we assume that there are two types of agents, rich and poor. Rich agents are Ricardian and buy one-period risk free bonds. Poor agents are assumed to be rule of thumb consumers. Both types of households consume both types of goods. To provide the subsidized agriculture good to the poor, the government imposes a lump sum tax on the rich and uses the proceeds to procure agricultural output from the open market. It then redistributes a fraction of the procured agriculture good to the poor. Higher procurement and redistribution, by leading to a higher subsidy of the agriculture good to the poor, leads to a larger reduction in the poor's market expenditures on the agriculture good. Further, we assume that rich agents have a higher intertemporal elasticity of substitution (IES) of consumption compared to the poor, which affects their labor supply decisions deferentially in response to changes in the real wage.[1]

The Indian agriculture sector is subject to frequent government interventions in the agriculture market.[2] Using Indian data, we estimate the model equations using the Bayesian method. Our Bayesian estimation gives us parameter values, which allows us to understand the mechanisms through which redistributive policy shocks impact economy wide and distributional variables in an empirically grounded framework.[3] From the impulse response functions (IRFs), we identify the transmission mechanism of agricultural productivity shocks, redistributive policy shocks, and monetary policy shocks to sectoral inflation rates, the economy-wide inflation rate, and consumption of rich and poor agents. We compare our results to a variety of benchmarks that emerge as special cases from our framework: a two sector representative agent NK framework along the lines of Aoki, a one sector two agent NK DSGE model

1. In Debortoli and Galí, all agents have the same intertemporal elasticity of substitution. Our assumption is driven by estimates of different intertemporal elasticity of substitution parameters for rich and poor households from Indian household data. See Atkeson and Ogaki (1996). Our assumption is also in line with some of the DSGE literature on the macroeconomic evaluation of LSAPs (large-scale asset purchase programs), where the intertemporal elasticity of substitution across households is assumed to be different. See Chen, Curdia, and Ferrero (2012).

2. India is an EMDE with a large agriculture sector and has less reliance on imports for meeting its food security needs—closer to our closed economy model.

3. Ginn and Pourroy (2019) estimate a Bayesian DSGE model using India data and show that food subsidy policies have large distributional effects. While our model focuses on redisributive policy shocks, they focus on world food price shocks.

along the lines of Debortoli and Galí, and the simple one sector one agent NK model in Galí (2015).[4] This allows us to isolate the impact of demand side factors (consumer heterogeneity) and supply side factors (multiple sectors) in determining sectoral and aggregate inflation rates, and rich and poor consumption in response to these shocks.

We show that a positive agricultural productivity shock leads to a decline in aggregate inflation, a decline in aggregate employment, a negative output gap, and a rise in both poor and rich consumption. In contrast, a procurement and redistributive policy shock leads to higher aggregate inflation, a positive output gap, lower consumption by the rich, higher consumption of the poor, and higher aggregate consumption in the economy. Because of the redistributive effect of the transfer, the rise in poor consumption makes aggregate consumption rise dominating the decline in rich consumption. Compared to the Aoki model, since the poor receive a fraction of their agricultural consumption for free (via the redistributive shock), the market demand for the agriculture good is less, and so the inflationary impact of a procurement and redistributive policy shock is much lower in our model compared to the Aoki model (where there is no redistribution).

In standard NK models, the optimal policy is designed to perfectly stabilize inflation at the natural level of output. In the presence of a flexible price sector, we would expect that the planner would not be able to smooth the variability in inflation in the flexible price sector and thus not be able to achieve full (headline) inflation stabilization.[5] To evaluate the welfare cost of redistributive policy shocks, we follow Schmitt-Grohe and Uribe (2007). We assume that the monetary authority acts like a utilitarian Ramsey planner and maximizes the weighted average of intertemporal utility functions of rich and poor households, subject to the private sector optimality conditions and the economy's feasibility constraints. This is referred to as Ramsey optimal monetary policy (ROMP) in the literature. To rank alternative policies, we compare (both conditional and unconditional) welfare under optimal simple rules (OSRs) and a variety of nonoptimized rules, and convert any improvements in welfare to consumption equivalent welfare gains.

Our main welfare results in Section 5 show that while a Ramsey planner can achieve close to full *core-inflation* stabilization (or sticky price inflation), *aggregate inflation* variability is lower under OSR compared to Ramsey. This is because under OSR, the monetary authority places a high weight on minimizing the variance of aggregate inflation, and chooses a Taylor parameter for inflation responsiveness to be the highest feasible value ($\phi_\pi = 3$). We also find that non-optimized rules (both simple Taylor and Standard Taylor) lead to consumption equivalents that are of an order of magnitude higher when compared to OSR. This suggests that redistributive policy

4. Both productivity shock and procurement and redistributive policy shock IRFs are benchmarked only to the Aoki model since Aoki has two production sectors, while both Debortoli and Galí and Galí (2015, Chapter 3) have a single sticky price manufacturing sector. In the case of Debortoli and Galí, their framework assumes incomplete markets, ours has complete markets. Parameter restrictions that yield their model can, therefore, be seen as an approximation of their framework.

5. It is well known that optimal policy design is model-dependent (see Woodford (2010)).

shocks are costly to both rich and poor households, especially when monetary policy is not set optimally.[6]

A recent focus in the monetary policy literature explores the impact of monetary policy in the presence of consumer heterogeneity (see McKay, Nakamura, and Steinsson 2016; Kaplan, Moll, and Violante 2018; Auclert 2019, and Broer et al. 2020). As in this research, we ask how heterogeneity matters for whether monetary policy responses to shocks raise aggregate welfare or not? Why is it important to take into account heterogeneity? In our model, consumer heterogeneity interacts with rich intersectoral dynamics to determine the differential response of rich and poor consumption, and, therefore, aggregate demand to shocks. We, therefore, compare our two-sector TANK model under a contractionary monetary policy shock with the simple NK framework in Galí (2015) (Chapter 3), the Aoki model, and Debortoli and Galí. In models with two sectors (our model and Aoki's), the presence of a flexible price sector creates a large deflation in the economy in response to a contractionary monetary policy shock. This is because a rise in the nominal interest rate leads to the intertemporal substitution of consumption, as in the standard NK model, which causes a reduction in aggregate demand and a decline in the aggregate price level and inflation. This decline becomes more pronounced when there is a flexible price sector in addition to a sticky price sector. Since the shock is of one period, agricultural inflation returns to the steady state in the next period. Manufacturing inflation, however, recovers gradually because of the sticky price assumption in all models. Crucially, in our model and Aoki's model, real interest rates increase by less, and, therefore, rich and poor consumption falls less compared to Debortoli and Galí and the simple NK model. The decline in aggregate consumption, therefore, is also less in our model and Aoki's model compared to the simple NK model and Debortoli and Galí. In all cases, consumer heterogeneity interacts with rich intersectoral dynamics to determine the general equilibrium responses to a variety of shocks.

An interesting insight from our analysis is that when the employment share of the manufacturing sector rises, output adjusts more compared to an economy with a higher share of the agriculture/flexible price sector, and the effectiveness of monetary policy is comparatively greater.[7] Our model, therefore, provides a rationale for why monetary policy is ineffective in economies with a large agricultural sector.

Our 2S-TANK framework builds on the seminal work by Galí and Monacelli (2005), Aoki (2001), and Debortoli and Galí (2024). The main difference with respect to these papers is that Galí and Monacelli (2005) consider an open economy framework, whereas we consider a closed economy framework. In Aoki (2001), there

6. When we fix the steady-state amount of agricultural output procured and assess the implication of varying steady-state redistribution on consumption equivalent welfare gains, we find that the volatility of poor consumption rises with the steady-state redistribution. We conduct a similar exercise using OSR. In both cases, poor agents are risk-averse and unable to smooth consumption. They, therefore, are willing to forgo a greater amount of their steady-state consumption to avoid fluctuations in consumption because of the redistributive policy shock. These results are discussed in Welfare Online Appendix A.3.2.

7. See Section A.1.6.3 in the Online Appendix for details.

are two production sectors, a flexible-price agriculture sector that is perfectly competitive, and a sticky-price manufacturing sector that is monopolistically competitive. The production side of our model is similar to Aoki's model. However, Aoki's model has a single representative agent. In our model, we allow for two types of agents, rich (Ricardian) and poor (rule of thumb) with different intertemporal elasticities of substitution in consumption and different budget constraints. Another difference with respect to Aoki (2001) is that the government in our model taxes rich agents, procures grain from the agriculture sector, and redistributes the agricultural good to poor agents. In Aoki's framework, there is no government intervention.[8]

Debortoli and Galí (2024) build a DSGE model in which agents are Ricardian/rich and rule of thumb/poor. They show that a TANK model provides a good approximation for studying the impact of aggregate shocks to aggregate variables in a baseline HANK (Heterogeneous agent New Keynesian) model. In Debortoli and Galí (2024), there is, however, only one production sector (sticky price sector). The main methodological contribution of our paper is to extend the two-agent one-sector framework of Debortoli and Galí to two sectors.

Our paper also builds on previous work in Ghate, Gupta, and Mallick (2018), or GGM. In GGM, there are three production sectors (grain, vegetables, and manufacturing). In that framework, all three sectors are monopolistically competitive, with the agriculture sector having flexible prices. The manufacturing sector is the sticky price sector. In the current framework, there are two production sectors (agriculture, manufacturing). Unlike GGM, the agriculture sector is characterized by a grain sector, which is assumed to be perfectly competitive. Like GGM, the manufacturing sector is the sticky price sector. In GGM, there is a single representative agent, that is, it is a RANK (Representative Agent New Keynesian) model. Our model has two types of agents.[9] Like GGM, however, our model illustrates how the terms of trade between agriculture and manufacturing play a crucial role in the transmission of monetary policy changes to aggregate outcomes.

In sum, the contribution of our paper is both methodological and policy-oriented. Using an NK DSGE setup, we integrate a two-sector production framework with a TANK model to examine the effects of redistributive policy shocks and their implications for monetary policy. We characterize optimal monetary policy and calculate the welfare costs associated with such policy interventions. Our analysis sheds light on the dynamics of food subsidies, their implications for inflation, and a better understanding of their general equilibrium effects.[10]

8. Galí, Vallés, and López-Salido (2007) use a two-agent framework (rule of thumb and Ricardian) to account for evidence on government spending shocks, but their focus is on fiscal policy, not monetary policy.

9. In the current framework, we do not model minimum support prices as we did in GGM. Our focus is to study the impact of redistributive policy shocks on rich-poor consumption and sectoral and aggregate inflation dynamics, and monetary policy setting in this context.

10. Our paper has relevance for the protests in India on the new farm laws introduced in November 2020. One of the demands of the farmers was to fix the minimum support price of agricultural products

2. THE MODEL

The model has two sectors: agriculture (A) and manufacturing (M). The A-sector is characterized by perfect competition and flexible prices, and produces a single homogeneous good. The M-sector is characterized by monopolistic competition and staggered price setting.[11] We assume that there are two types of households: poor (P) and rich (R). The fraction of rich households is exogenously given and denoted by μ_R. The rest $(1 - \mu_R)$ are poor. The poor and rich can either work in the A sector or the M sector, that is, there is perfect mobility of labor across sectors.[12] Poor households are assumed to be rule of thumb (or hand to mouth) consumers and do not have bond holdings. Rich households are forward-looking Ricardian consumers and hold bonds. They own firms and supply labor to these firms, thereby receiving both dividends and labor income. In contrast, poor households only supply labor to the firms owned by the rich, and so their only source of income is labor income.

Like GGM, the government procures grain in the open market. It does this by imposing a lump-sum tax on the rich and uses the proceeds to procure/buy A-sector output from the market at the market price.[13] It then redistributes a fraction of the procured A good to poor households. Hence, redistribution goes to the poor households, rather than any particular sector. The rich households also have higher incomes than the poor since the poor households only have labor income, whereas rich households have labor and dividend income.

Following Atkeson and Ogaki (1996), who show that the IES in consumption rises with wealth in Indian data, we assume that the poor have a lower IES than the rich. This means that the poor are less willing to substitute consumption across time periods. This allows labor responses of the rich and poor to differ for a given change in the real wage (see Chen, Curdia, and Ferrero (2012)).

2.1 Households

All households are assumed to have identical preferences.[14] At time 0, a household of type K $(= R, P)$ maximizes its expected lifetime utility given by

$$E_0 \sum_{t=0}^{\infty} \beta^t \left[U\left(C_{K,t}\right) - V\left(N_{K,t}\right) \right], \tag{1}$$

by a committee of stakeholders, which would include farmers. A higher minimum support price would increase the amount of the food subsidy.

11. The manufacturing sector can also be termed as the "nonagriculture" sector. The names are not crucial. What is crucial is that one sector is a flexible price sector, and the other is a sticky price sector.

12. We relax this assumption in an extension of the model. See Online Appendix A.1.6.1.

13. The seller of the A good can be either poor or rich.

14. All derivations for the model in Sections 2 and 3 are in Online Appendix A.1.

where $C_{K,t}$ is a consumption index, and $N_{K,t}$ is labor supply. The subscript $K \in \{R, P\}$ specifies the household type. A household of type K derives utility from consumption, $C_{K,t}$, and disutility from supplying labor, $N_{K,t}$. $\beta \in (0, 1)$ is the discount factor. The period utility function is specified as:

$$U\left(C_{K,t}\right) = \frac{C_{K,t}^{1-\sigma_K}}{1-\sigma_K}, \tag{2}$$

$$V\left(N_{K,t}\right) = \frac{N_{K,t}^{1+\varphi}}{1+\varphi}, \tag{3}$$

where σ_K and φ, respectively, are the inverse of the IES for consumer type K, and the inverse of the Frisch labor supply elasticity, which is assumed to be the same for both types of households. Consumption of both rich and poor households depend on goods consumed from both sectors and follow Cobb–Douglas indices of agriculture (A) and manufacturing (M) consumption and is given by:

$$C_{K,t} = \frac{C_{K,A,t}^{\delta_K} C_{K,M,t}^{1-\delta_K}}{\delta_K^{\delta_K}(1-\delta_K)^{1-\delta_K}}; \qquad \text{for } K = R \text{ and } P, \tag{4}$$

where $\delta_K \in [0, 1]$ is the share of income spent on agriculture goods by the K^{th} type of agent. Consumption in the manufacturing sector is a CES aggregate of a continuum of differentiated goods indexed by $j \in [0, 1]$, where $P_{M,t}(j)$ is the price level of the j^{th} variety of the M-sector good, that is, [15] $C_{K,M,t} = \left(\int_0^1 C_{K,M,t}\,(j)^{\frac{\varepsilon-1}{\varepsilon}}\, dj\right)^{\frac{\varepsilon}{\varepsilon-1}}$, $\varepsilon > 1$.

Rich households maximize utility given in equation (1) subject to the following intertemporal budget constraint

$$\int_0^1 \left[P_{M,t}(j)C_{R,M,t}(j)\right]dj + P_{A,t}C_{R,A,t} + E_t\{Q_{t+1}B_{t+1}\} \le B_t + W_t N_{R,t} - T_{R,t} + Div_t, \tag{5}$$

where Q_{t+1} is the stochastic discount factor, B_{t+1} are the nominal payoffs in period $t+1$ of the bonds held at the end of period t, $T_{R,t}$ is the lump-sum tax paid to the government, and Div_t is the dividend income distributed to households by monopolistically competitive firms. Labor is assumed to be completely mobile across sectors, with the nominal wage rate given by W_t. We assume that the A sector produces a single homogeneous good, whose price is $P_{A,t}$.

15. The demand functions for goods within manufacturing varieties are

$$C_{K,M,t}(j) = \left(\frac{P_{M,t}(j)}{P_{M,t}}\right)^{-\varepsilon} C_{K,M,t}$$

for $K = R$ and P.

To model a procurement-redistribution style intervention in an EMDE, the government in every period procures the agriculture good at the open market price, $P_{A,t}$. Part of the procured agriculture good is rebated back to each poor household as a subsidy, $C^S_{P,A,t}$, while the remaining portion is put into a buffer stock.[16] Of the total consumption of the agriculture good by the poor household, $C_{P,A,t}$, a fraction, λ_t, is subsidized (it is given for free). That is, $C^S_{P,A,t} = \lambda_t C_{P,A,t}$ The remaining fraction, $(1-\lambda_t)$, of $C_{P,A,t}$ is purchased from the open market ($C^O_{P,A,t}$), which implies

$$C^S_{P,A,t} + C^O_{P,A,t} = C_{P,A,t}. \tag{6}$$

Poor households are assumed to be rule of thumb consumers, and maximize their current utility (1) subject to the following (static) budget constraint

$$\int_0^1 \left[P_{M,t}(j)C_{P,M,t}(j)\right]dj + P_{A,t}C^O_{P,A,t} \leq W_t N_{P,t}, \tag{7}$$

where $P_{A,t}C^O_{P,A,t}$ denotes the nominal value of open market purchases of the agriculture goods by the poor. The poor agent derives utility from the amount of the agriculture good consumed, while the expenditure depends only on a fraction, $1-\lambda_t$, of the quantity consumed. It is easy to see that equation (7) can be rewritten as:

$$\int_0^1 \left[P_{M,t}(j)C_{P,M,t}(j)\right]dj + P_{A,t}(1-\lambda_t)C_{P,A,t} \leq W_t N_{P,t}. \tag{8}$$

Hence, the proportional quantity subsidy can be interpreted as a price subsidy. We define: $P^{'}_{A,t} = (1-\lambda_t)P_{A,t}$, which is the effective price of the agriculture good paid by the poor agent.

2.1.1 Optimal allocations. Optimal consumption allocations by the rich for A and M goods are given, respectively, by

$$C_{R,A,t} = \delta_R \left(\frac{P_{A,t}}{P_t}\right)^{-1} C_{R,t}, \tag{9}$$

$$C_{R,M,t} = (1-\delta_R)\left(\frac{P_{M,t}}{P_t}\right)^{-1} C_{R,t}, \tag{10}$$

where the aggregate price level is given by $P_t = P^{\delta_R}_{A,t} P^{1-\delta_R}_{M,t}$.

For poor households, consumption allocations for the A and M goods are given, respectively, by

16. An equivalent interpretation is that nonredistributed procured output is wasted, or *thrown into the ocean*. We do not endogenize buffer stock dynamics in this paper.

$$C_{P,A,t} = \delta_P \left(\frac{P'_{A,t}}{P'_t} \right)^{-1} C_{P,t}, \tag{11}$$

$$C_{P,M,t} = (1-\delta_P)\left(\frac{P_{M,t}}{P'_t} \right)^{-1} C_{P,t}, \tag{12}$$

where the price index for the poor is given by: $P'_t = \left\{(1-\lambda_t)P_{A,t}\right\}^{\delta_p} P_{M,t}^{1-\delta_p}$. Because of the policy, λ_t, the rich and poor face different price indices.

Using the fact that $C_{R,M,t}(j) = \left(\frac{P_{M,t}(j)}{P_{M,t}}\right)^{-\varepsilon} C_{R,M,t}$ and the demand functions in (9) and (10) implies that the budget constraint for the rich can be rewritten as:

$$P_t C_{R,t} + E_t\{Q_{t+1}B_{t+1}\} \leq B_t + W_t N_{R,t} - T_{R,t} + Div_t. \tag{13}$$

For the poor, using equations (11) and (12) implies

$$P'_t C_{P,t} \leq W_t N_{P,t}, \tag{14}$$

where $C_{R,t}$ and $C_{P,t}$ denote the consumption indices (over the agriculture good and manufacturing good) of the rich and poor households, respectively. As seen in equation (14), the impact of subsidizing the agriculture good for poor households reduces the effective price of the consumption basket to P'_t.

The solutions to maximizing equation (1) subject to equation (13) for the rich and equation (14) for the poor yield the following optimality conditions:

$$1 = \beta E_t\left[\left(\frac{C_{R,t+1}}{C_{R,t}}\right)^{-\sigma_R} \frac{P_t}{P_{t+1}} R_t\right], \tag{15}$$

$$\frac{W_t}{P_t} = \frac{N_{R,t}^{\varphi}}{C_{R,t}^{-\sigma_R}} \text{ for the rich,} \tag{16}$$

$$\frac{W_t}{P'_t} = \frac{N_{P,t}^{\varphi}}{C_{P,t}^{-\sigma_P}} \text{ for the poor,} \tag{17}$$

where $R_t = \frac{1}{E_t\{Q_{t+1}\}}$ is the gross nominal return on the riskless one-period bond.

2.1.2 Terms of trade. Terms of trade (TOT) between the agriculture and the manufacturing sectors is defined as $T_t = \frac{P_{A,t}}{P_{M,t}}$. CPI inflation is given by $\pi_t = \ln P_t - \ln P_{t-1}$, and the sectoral inflation rates are given by as $\pi_{A,t} = \ln P_{A,t} - \ln P_{A,t-1}$ and $\pi_{M,t} = \ln P_{M,t} - \ln P_{M,t-1}$, respectively, for the agriculture and the manufacturing sectors. From the aggregate price index, CPI inflation can also be written in terms of TOT as:

$$\pi_t = \delta_R \pi_{A,t} + (1-\delta_R)\pi_{M,t} = \delta_R \Delta T_t + \pi_{M,t}. \tag{18}$$

2.1.3 Sectoral aggregates. We define aggregate agricultural consumption as a weighted average of rich and poor agricultural consumption with μ_R being the share of the rich in the population:

$$C_{A,t} = \mu_R C_{R,A,t} + (1 - \mu_R) C_{P,A,t}. \tag{19}$$

The total amount of redistributed grain and the consumption subsidy to the poor is given by:

$$(1 - \mu_R) C^S_{P,A,t} = \phi_t Y^P_{A,t}, \tag{20}$$

where the government redistributes a fraction, $\phi_t \in [0, 1]$, of procured goods, $Y^P_{A,t}$, to the poor. Substituting out for $C_{P,A,t}$ from (11) yields

$$\underbrace{C_{A,t}}_{\text{Total Ag. Con}} = \underbrace{\mu_R \delta_R \left(\frac{P_{A,t}}{P_t} \right)^{-1} C_{R,t}}_{\text{Ag.Con. by Rich}} + \underbrace{(1 - \mu_R) \delta_P \left(\frac{P'_{A,t}}{P'_t} \right)^{-1} C_{P,t}}_{\text{Ag.Con. by Poor}}. \tag{21}$$

This implies

$$C_{A,t} = \mu_R \delta_R T_t^{-(1-\delta_R)} C_{R,t} + (1 - \mu_R) \delta_p \{(1 - \lambda_t) T_t\}^{-(1-\delta_p)} C_{P,t}. \tag{22}$$

Likewise, $C_{M,t} = \mu_R C_{R,M,t} + (1 - \mu_R) C_{P,M,t}$ which implies

$$C_{M,t} = \mu_R (1 - \delta_R) T_t^{\delta_R} C_{R,t} + (1 - \mu_R)(1 - \delta_P) \{(1 - \lambda_t) T_t\}^{\delta_p} C_{P,t}. \tag{23}$$

These last two equations imply that total agriculture and manufacturing consumption depends on rich and poor consumption, and the TOT.

2.2 Firms

In the manufacturing sector, there is a continuum of firms indexed by j. Each firm produces a differentiated good with a linear technology given by the production function $Y_{M,t}(j) = A_{M,t} N_{M,t}(j)$. We assume that productivity shocks are the same across firms and follow an AR(1) process,

$$\log A_{M,t} - \log A_M = \rho_M \big(\log A_{M,t-1} - \log A_M \big) + \varepsilon_{M,t}$$

where $\varepsilon_{M,t} \sim i.i.d(0, \sigma_M)$. The nominal marginal costs are common across firms and are given by $MC_{M,t} = (1 + \tau_M) \frac{W_t}{A_{M,t}}$, where τ_M is the employment subsidy given to manufacturing production. Real marginal cost is written as:

$$mc_{M,t} = \frac{MC_{M,t}}{P_{M,t}} = (1 + \tau_M) \frac{W_t}{P_t} T_t^{\delta_R} \frac{1}{A_{M,t}}. \tag{24}$$

Let $Y_{M,t} = \left(\int_0^1 Y_{M,t}(j)^{\frac{\varepsilon-1}{\varepsilon}} dj \right)^{\frac{\varepsilon}{\varepsilon-1}}$, where $\varepsilon > 1$. Output demand is given by $Y_{M,t}(j) = \left(\frac{P_{M,t}(j)}{P_{M,t}} \right)^{-\varepsilon} Y_{M,t}$. The labor supply allocation in manufacturing sector is obtained as:

$$N_{M,t} = \int_0^1 N_{M,t}(j)dj = \frac{Y_{M,t}}{A_{M,t}} Z_{M,t}, \tag{25}$$

where $Z_{M,t} = \int_0^1 \left(\frac{P_{M,t}(j)}{P_{M,t}} \right)^{-\varepsilon} dj$ represents the price dispersion term. Equilibrium variations in $\ln \int_0^1 \left(\frac{P_{M,t}(j)}{P_{M,t}} \right)^{-\varepsilon} dj$ around perfect foresight steady state are of second order. Given that the agriculture sector is characterized by flexible price and perfect competition, we can write the sectoral aggregate production as:

$$Y_{A,t} = A_{A,t} N_{A,t}, \tag{26}$$

where the productivity shock follows an AR(1) process,

$$\log A_{A,t} - \log A_A = \rho_A \left(\log A_{A,t-1} - \log A_A \right) + \varepsilon_{A,t}, \tag{27}$$

where $\varepsilon_{A,t} \sim i.i.d(0, \sigma_A)$. Nominal marginal costs in the agriculture sector are given by $MC_{A,t} = \frac{W_t}{A_{A,t}}$.

2.2.1 Price setting in the manufacturing sector. Price setting follows Calvo (1983), and is standard in the literature. Firms adjust prices with probabilities $(1 - \theta)$ independent of the time elapsed since the previous adjustment. The inflation dynamics under such price setting is

$$\pi_{M,t} = \beta E_t\{\pi_{M,t+1}\} + \kappa \widetilde{mc}_{M,t}, \tag{28}$$

where $\kappa = \frac{(1-\beta\theta)(1-\theta)}{\theta}$, and $\widetilde{mc}_{M,t}$ is the deviation of the real marginal cost in the manufacturing sector from its natural rate.

2.3 Government Procurement

In each period, the government procures $Y^P_{A,t}$ amount of agricultural output at the market price $P_{A,t}$ using the tax receipts from the rich and redistributes a fraction ($\phi_t \in [0, 1]$) of procured goods to the poor.[17] The redistributed amount is given by $\phi_t Y^P_{A,t}$.

17. When P is used as a superscript, it refers to procurement. When P is a subscript, it refers to the poor.

The agriculture sector output is the sum of consumption and the amount accumulated by the buffer stock.

$$Y_{A,t} = C_{A,t} + (1 - \phi_t) Y^P_{A,t}, \tag{29}$$

where the total consumption of the agriculture good $C_{A,t}$ consists of the total amount consumed (by both the rich and poor). A procurement shock is given by an AR(1) process,

$$\ln Y^P_{A,t} - \ln Y^P_A = \rho_{Y^P_A} (\ln Y^P_{A,t-1} - \ln Y^P_A) + \varepsilon_{Y^P_{A,t}}, \tag{30}$$

where $\rho_{Y^P_A} \in (0, 1)$ and $\varepsilon_{Y^P_{A,t}} \sim i.i.d(0, \sigma_{Y^P_A})$. Redistributive policy shocks, denoted by changes in ϕ_t, capture sudden increases in the *fraction* of procured grain redistributed to the poor, and are given by the following AR(1) process,

$$\ln \phi_t - \ln \phi = \rho_\phi (\ln \phi_{t-1} - \ln \phi) + \varepsilon_\phi, \tag{31}$$

where $\rho_\phi \in (0, 1)$ and $\varepsilon_\phi \sim i.i.d(0, \sigma_\phi)$. Higher procurement and redistribution, by leading to a higher subsidy of the agricultural good to the poor as shown in equation (20), leads to a larger reduction in the poor's expenditures on the agriculture good.

3. EQUILIBRIUM DYNAMICS

3.1 Market Clearing

Market clearing is given by the following equations:

$$C_t = \mu_R C_{R,t} + (1 - \mu_R) C_{P,t} (1 - \lambda_t)^{-(1-\delta_p)} T_t^{\delta_p - \delta_R} \big(1 - \lambda_t (1 - \delta_p)\big), \tag{32}$$
$$N_t = N_{A,t} + N_{M,t}, \tag{33}$$
$$Y_{M,t} = C_{M,t}, \tag{34}$$
$$Y_t = C_t + T_t^{1-\delta_R} Y^P_{A,t} (1 - \phi_t), \tag{35}$$
$$Y_t = T_t^{1-\delta_R} Y_{A,t} + T_t^{-\delta_R} Y_{M,t}, \tag{36}$$
$$\mu_R T_{R,t} = \big[(1 - \phi_t) Y^P_{A,t} + C^S_{P,A,t} (1 - \mu_R)\big] P_{A,t} = P_{A,t} Y^P_{A,t}, \tag{37}$$

and equation (29). Equation (32) corresponds to aggregate consumption by both rich and poor households obtained by adding nominal values of agriculture and manufacturing consumption, weighted by their respective masses, μ_R, and $1 - \mu_R$ in the population (which is normalized to 1), and deflating by the price index. Both the policy, λ_t, and the TOT, T_t, are seen to affect aggregate consumption positively.[18] The labor

18. Comparative statics suggest that higher redistribution (higher λ, holding T constant) lowers the effective price index of the poor agent. This leads to a positive income effect. Holding λ constant and raising T leads to higher consumption, as a higher TOT has a positive impact on output, as shown in equation (36).

market clearing condition is given by equation (33). The agriculture market clearing condition is given by equation (29). The manufacturing goods market clearing condition is given by equation (34). The aggregate goods market clearing condition is given by equation (35), which can be written in terms of T_t as in equation (36). Equation (37) is the government budget constraint, which equates lump sum taxes collected from the rich to the nominal value of redistribution ($C^S_{P,A,t}P_{A,t}(1-\mu_R)$) and the fraction of procured output that goes toward buffer stock accumulation ($(1-\phi_t)Y^P_{A,t}P_{A,t}$).

3.2 *Log-Linearization*

We present the log-linearized expressions for $\widehat{C}_{P,t}$ and $\widehat{C}_{R,t}$, as these give the differential impact on consumption of the poor and rich from a variety of shocks. Derivation and discussion of the complete log-linearized model and the steady state are in Online Appendix A.1. Log-linearization of the aggregate market clearing condition (equation (35)) gives:

$$\begin{aligned} \widehat{Y}_t &= c\widehat{C}_t + (1-c)\left[(1-\delta_R)\widehat{T}_t + \widehat{Y}^P_{A,t} - \left(\frac{1}{1-\phi}\right)\widehat{\phi}_t\right] \\ &= \left(\frac{1-\mu_A}{1-\bar{\delta}}\right)\widehat{C}_t + \left(\frac{\mu_A-\bar{\delta}}{1-\bar{\delta}}\right)\left[(1-\delta_R)\widehat{T}_t + \widehat{Y}^P_{A,t} - \left(\frac{1}{1-\phi}\right)\widehat{\phi}_t\right], \end{aligned} \tag{38}$$

where c is the steady-state consumption share in output and is defined in equation (A.63). Log-linearization of aggregate consumption, C_t, in equation (32) gives

$$\widehat{C}_t = s_R\widehat{C}_{R,t} + (1-s_R)\left\{(1-\lambda_p\tau)\widehat{C}_{P,t} + \lambda_p\tau\left(\frac{\widehat{\phi}_t}{\phi} + \widehat{Y}^P_{A,t}\right) + \left[\delta_p - \delta_R + \lambda_p\tau(1-\delta_p)\right]\widehat{T}_t\right\} \tag{39}$$

where s_R is the steady consumption share of the rich households, and $\tau = \frac{\lambda(1-\delta_p)}{1-\lambda(1-\delta_p)}$.[19] Log-linearization of the first-order conditions (equations (16) and (17)) for the rich and poor households give

$$\widehat{W}_t - \widehat{P}_t = \varphi\widehat{N}_{R,t} + \sigma_R\widehat{C}_{R,t} \tag{40}$$

and

$$\widehat{W}_t - \widehat{P}_t = \varphi\widehat{N}_{P,t} + \sigma_P\widehat{C}_{P,t} - \frac{\delta_p}{1-\lambda}\hat{\lambda}_t + (\delta_p - \delta_R)\widehat{T}_t. \tag{41}$$

19. We assume that the share of rich in employment is equal to the share of rich in the population $0 < \mu_R < 1$, that is, $N_{R,t} = \mu_R N_t$ and $N_{P,t} = (1-\mu_R)N_t$. This implies that $\widehat{N}_{R,t} = \widehat{N}_{P,t} = \widehat{N}_t$ for all t.

The log-linearized consumption of the poor, $\widehat{C}_{P,t}$, is given by

$$\widehat{C}_{P,t} = \frac{\sigma_R}{\sigma_P + \lambda_p}\widehat{C}_{R,t} + \frac{\lambda_p}{\sigma_P + \lambda_p}\left[\frac{\widehat{\phi}_t}{\phi} + \widehat{Y}^P_{A,t}\right] - \left\{\frac{\delta_p - \delta_R - \lambda_p(1-\delta_p)}{\sigma_P + \lambda_p}\right\}\widehat{T}_t. \quad (42)$$

Note that $\widehat{C}_{P,t}$ is increasing in the redistribution shock, $\widehat{\phi}_t$, the steady-state deviation of procurement, $\widehat{Y}^P_{A,t}$, and is affected negatively by the steady-state deviation of the TOT, $\widehat{T}_t$. An increase in procurement and redistribution induces a "redistribution-effect," which raises consumption of the poor because it provides subsidized goods. An increase in the consumption of the rich raises the consumption of the poor, due to the assumption that the labor supply of both groups remains a constant fraction of total labor supply. The TOT exert a negative impact on consumption as a higher relative price of the agriculture good makes the consumption basket of the poor more expensive. This induces the poor to buy less agricultural output. If both the rich and poor households have the same IES, that is, $\sigma_R = \sigma_P$, $\delta_p = \delta_R$, and there is no redistributive policy, that is, $\lambda = 0$, then $\widehat{C}_t = \widehat{C}_{R,t} = \widehat{C}_{P,t}$.

Log-linearization of the Euler equation (15) for the rich households around zero inflation in the steady state gives

$$\widehat{C}_{R,t} = E_t\{\widehat{C}_{R,t+1}\} - \frac{1}{\sigma_R}\left[\widehat{R}_t - E_t\{\Pi_{t+1}\}\right]. \quad (43)$$

Substituting $\widehat{C}_{P,t}$ in equation (42) into (39), solving for $\widehat{C}_{R,t}$, and substituting the resulting expression for $\widehat{C}_{R,t}$ in equation (43), gives us the Euler equation in terms of aggregate consumption, $\widehat{C}_t$, as

$$\widehat{C}_t = E_t\{\widehat{C}_{t+1}\} - \Phi^{-1}\left[\widehat{R}_t - E_t\{\Pi_{t+1}\}\right] - \Psi E_t \left\{\frac{\Delta\widehat{\phi}_{t+1}}{\phi} + \Delta\widehat{Y}^P_{A,t+1} + \left\{\left(1-\delta_p\right) + \left(\delta_p - \delta_R\right)z\right\}\Delta\widehat{T}_{t+1}\right\} \quad (44)$$

where

$$\Phi = \frac{\sigma_R(\sigma_P + \lambda_p)}{s_R(\sigma_P + \lambda_p) + (1 - s_R)\sigma_R(1 - \lambda_p\tau)}, \quad (45)$$

$\Psi = \frac{\lambda_p(1-s_R)(1+\sigma_p\tau)}{\sigma_P+\lambda_p}$, and $z = \frac{\sigma_p+\lambda_p-(1-\lambda_p\tau)}{\lambda_p(1+\sigma_p\tau)}$. With $\sigma_R = \sigma_P$, $s_R = 1$, and $\lambda = 0$, equation (44) becomes the standard Euler equation for homogenous households.

3.3 Gap Variables

Define $\widehat{X}^N_t$ as the deviation of $\ln X_t$ under flexible prices from the steady state, that is, $\widehat{X}^N_t = \ln X^N_t - \ln X$. Also, define the gap of a variable as $\widetilde{X}_t = \widehat{X}_t - \widehat{X}^N_t$. Then, the dynamic IS equation (DIS) is given by

$$\widetilde{Y}_t = E_t\left\{\widetilde{Y}_{t+1}\right\} - c\Phi^{-1}\left[\widehat{R}_t - E_t\{\Pi_{t+1}\} - \widehat{R}_t^N\right], \quad (46)$$
$$- \left[(1-\delta_R)(1-c) + \Psi c\left\{(1-\delta_p) + (\delta_p - \delta_R)z\right\}\right]E_t\left\{\Delta\widetilde{T}_{t+1}\right\}$$

where $\widehat{R}_t^N$ is the real natural interest rate and is given by

$$\widehat{R}_t^N = -\left[\Psi\Phi(1-\Lambda^{-1}\Phi) + \varphi(1-c)\Lambda^{-1}\Phi\right]E_t\left\{\Delta\widehat{Y}_{PA,t+1}\right\} \quad (47)$$
$$-\left[\frac{\Psi\Phi}{\phi}(1-\Lambda^{-1}\Phi) - \Lambda^{-1}\Phi\varphi(1-c)\left(\frac{1}{1-\phi}\right)\right]E_t\left\{\Delta\widehat{\phi}_{t+1}\right\}$$
$$+ \Phi\Lambda^{-1}E_t\left[\varphi\Delta\widehat{A}_{t+1} + \Delta\widehat{A}_{M,t+1}\right] + \Phi\left[\Psi(1+\Lambda^{-1}\Phi)\left(1-\delta_p\right.\right.$$
$$\left.+(\delta_p-\delta_R)z\right) + \Lambda^{-1}\left\{(1-s_R)\varphi c(\delta_p\tau + \delta_p - \delta_R) - \delta_R\right\}\Big]\, E_t\left\{\Delta\widehat{T}_{t+1}^N\right\}.$$

The NKPC (New Keynesian Phillips Curve) in terms of manufacturing sector inflation, the consumption gap, and the TOT gap is given by

$$\pi_{M,t} = \beta E_t\{\pi_{M,t+1}\} + \kappa\Lambda\widetilde{C}_t + \kappa\left[\delta_R - (1-s_R)\varphi c(\delta_p\tau + \delta_p - \delta_R)\right.$$
$$\left.-\Psi\Phi\{1-\delta_p + (\delta_p - \delta_R)z\}\right]\widetilde{T}_t. \quad (48)$$

We can also express the NKPC in terms of aggregate inflation and the output gap,

$$\pi_t = \beta E_t\{\pi_{t+1}\} + \frac{\kappa\Lambda}{c}\widetilde{Y}_t$$
$$+\kappa\left[\delta_R - (1-s_R)\varphi c(\delta_p\tau + \delta_p - \delta_R) - \Psi\Phi(1-\delta_p + (\delta_p-\delta_R)z)\ -(1-\delta_R)\left(\frac{\mu_A - \bar{\delta}}{1-\mu_A}\right)\right]\widetilde{T}_t$$
$$+\delta_R\Delta\widetilde{T}_t - \beta\delta_R E_t\{\Delta\widetilde{T}_{t+1}\}. \quad (49)$$

Equations (46), the Dynamic IS curve, and (49), the New Keynesian Phillips curve, summarize the nonpolicy block of the economy in our two-sector two-agent framework.

How do these equations differ compared to the simple NK model in Galí (2015) with a single agent and a single sticky price sector? There are three key differences between the current framework and such a benchmark. The first difference is that there are two sectors, which implies that the TOT, T_t, appear in the NKPC and the DIS. The second difference is that we have two types of agents (i.e., $s_R \neq 1$) who have different IES's ($\sigma_R \neq \sigma_P$), and in general, different shares of agriculture in consumption ($\delta_R \neq \delta_p$). The third difference is that there is (steady state) procurement and redistribution in the current framework, that is, $\mu_A - \bar{\delta} > 0$, and $\lambda > 0$. When $\mu_A - \bar{\delta} > 0$, this implies that the employment share and consumption share in agriculture diverge, that is, $c = \frac{C}{Y} = \frac{1-\mu_A}{1-\bar{\delta}} < 1$. Hence, $\mu_A - \bar{\delta} > 0$ drives a wedge between consumption and production in the aggregate economy.[20]

3.4 Monetary Policy Rule

Monetary policy follows a simple Taylor rule with the nominal interest rate as a function of aggregate inflation and the economy-wide output gap as in Anand, Prasad, and Zhang (2015) and Ginn and Pourroy (2019). We use a standard generalization of Taylor (1993):

$$R_t = (R_{t-1})^{\phi_r} (\pi_t)^{(1-\phi_r)\phi_\pi} \left(\widetilde{Y}_t\right)^{(1-\phi_r)\phi_y}. \tag{50}$$

The log-linearized version of the Taylor rule shows that

$$\hat{R}_t = \phi_r \hat{R}_{t-1} + (1-\phi_r)\phi_\pi \pi_t + (1-\phi_r)\phi_y \widetilde{Y}_t, \tag{51}$$

that is, the nominal interest rate, $\hat{R}_t$, depends on its lagged value, $\hat{R}_{t-1}$, aggregate inflation's deviation from its target, π_t, and the aggregate output gap, $\widetilde{Y}_t$. This closes the model.

4. QUANTITATIVE ANALYSIS

We estimate the model using a Bayesian approach, as is standard in empirical macro research (see Schorfheide(2000), Fernández-Villaverde and Rubio-Ramírez (2004)). In the Indian context, Bayesian estimation has been used to estimate the structural parameters of an NK-DSGE model with an agriculture sector (Ginn and Pourroy (2019)). We supplement the estimated parameters in our analysis with some calibrated parameters, as described below.

4.1 Data

We use Indian time series data for the 1994 Q2–2019 Q4 period. Our variables include Gross Domestic Product at 2011–12 prices, Private Final Consumption Expen-

20. Suppose $s_R = 1$, $\mu_A = \delta_R = \delta_p = 0$ (*which implies* $\bar{\delta} = 0$), $\sigma_R = \sigma_P$, and $\lambda = 0$. Then, equation (46) is given by

$$\widetilde{Y}_t = E_t\{\widetilde{Y}_{t+1}\} - \frac{1}{\sigma_R}\left[\widehat{R}_t - E_t\{\Pi_{t+1}\} - \widehat{R}_t^N\right],$$

where $\widehat{R}_t^N = \frac{\sigma_R(1+\varphi)}{\varphi+\sigma_R} E_t\left[\triangle \hat{A}_{M,t+1}\right]$, which is the DIS equation in the simple NK model as in Galí (2015). Further, the New Keynesian Phillips Curve in equation (49) is given by

$$\pi_t = \beta E_t\{\pi_{t+1}\} + \kappa(\varphi + \sigma_R)\widetilde{Y}_t$$

which is the NKPC in the simple NK model, where $\pi_t = \pi_{M,t}$ and $\widetilde{Y}_t = \widetilde{Y}_{M,t}$.

TABLE 1

Data Sources for Bayesian Estimation

Description	Source	Frequency
GDP at 2011–12 Prices	National Account Statistics	Quarterly
PFCE at 2011–12 Prices	National Account Statistics	Annual
Average daily wage rates	Wage Rates in Rural India	Monthly
Persons employed in Agriculture	INDIA KLEMS 2021	Annual
Persons employed in Manufacturing	INDIA KLEMS 2021	Annual
TFP in Agriculture	INDIA KLEMS 2021	Annual
TFP in Manufacturing	INDIA KLEMS 2021	Annual
Terms of Trade	INDIA KLEMS 2021	Annual
CPI	National Statistics Office	Monthly
Interest Rate	RBI-DBIE	Quarterly
Procurement of rice and wheat	RBI-DBIE	Annual
Redistribution of rice and wheat	RBI-DBIE	Annual

TABLE 2

Calibrated Parameters

Variable	Notation	Value	Source
Discount factor	β	0.9823	Gabriel et al. (2012)
Population share of rich	μ_R	0.3279	Calculated by Authors
Steady state employment share in agriculture	μ_A	0.48	Calculated by Authors
Expenditure share of agriculture - Rich	δ_R	0.3527	Calculated by Authors
Out of pocket Expenditure share of agriculture - Poor	δ_P	0.4807	Calculated by Authors
Elas. of Subs. between varieties of $M-$ good	ε	7.02	Gabriel et al. (2012)
Measure of price stickiness (M)	θ	0.75	Gabriel et al. (2012)

diture at 2011–12 prices, average daily wage rates for men (in Rs), persons employed in agriculture and manufacturing, total factor productivity in agriculture and manufacturing, intersectoral TOT, consumer price inflation, procurement, and off-take of rice and wheat.[21] The variable selection, data sources, and frequency are described in Table 1.

4.2 Calibration Parameters

Our analysis includes the following calibrated variables, as shown in Table 2. Following Gabriel et al. (2012), we set the discount factor $(\beta) = 0.9832$, the measure of

21. Sectoral employment data (in 1000s) are taken from EMP series, while sectoral total factor productivity and intersectoral TOT are computed using $TFPG_{va}$ and VA series from INDIA KLEMS Database 2021 (Das et al. (2021)). Quarterly averages of agricultural and nonagricultural wage data are constructed using the Wage Rates in Rural India series. The economy-wide wage rate is computed as a weighted average of male agricultural and nonagricultural wages (in rupees), using employment shares as weights. The 3-month Treasury bill rate from the Reserve Bank of India's Database on Indian Economy (RBI-DBIE) is used as the measure of the interest rate. Procurement and redistribution of rice and wheat (in Lakh [100,000] tons) have been sourced from Table 27: Public Distribution System - Procurement, Off-take and Stocks RBI's Handbook of Statistics on the Indian Economy (2019).

price stickiness for manufacturing goods (θ) = 0.75, and the elasticity of substitution between varieties of manufacturing goods (ϵ) = 7.02. We set the steady-state employment share in agriculture ($\mu_A = 0.48$) using data from the 2011–2012 Employment and Unemployment Survey (Ministry of Statistics and Programme Implementation (2014) 68^{th} round). The population share of the rich is the percentage of the population not receiving food grains under the NFSA 2013. Using population estimates from the Office of the Registrar General and Census Commissioner, India (2011), we find $\mu_R = 0.3279$. The expenditure share of agriculture for the rich ($\delta_R = 0.3527$), and the poor ($\delta_P = 0.4807$), are determined by the share of cereals and cereal substitutes in total expenditures net of expenditures on services, durable goods, vegetables, fuels (see the Data Online Appendix A.2 for details).

We use the previous literature with two-agent or two-sector model structures to inform our priors. We use the study by Anand and Prasad (2010) to determine the Frisch elasticity of labor supply (φ) to be 3. We follow Anand and Prasad (2010) in calibrating values for persistence and the standard deviation of food and nonfood productivity shocks. In particular, we use the prior that the agriculture and manufacturing productivity shocks have persistence of $\rho_A = 0.25$, $\rho_M = 0.95$, respectively, and standard errors of $\sigma_A = 0.03$ and $\sigma_M = 0.02$, respectively. We use Atkeson and Ogaki (1996) to determine the intertemporal elasticity of consumption substitution for both agents ($\frac{1}{\sigma_R} = 0.8$ and $\frac{1}{\sigma_P} = 0.5$). Following Banerjee, Basu, and Ghate (2012), we fix the interest rate smoothing parameter to be $\phi_r = 0.66$, inflation stabilization coefficient to be $\phi_\pi = 1.2$, and the output gap stabilization coefficient $\phi_y = 0.5$.

4.3 *Estimation Method*

The annual series are converted to a quarterly frequency using natural cubic spline interpolation. The variables (except interest rate, inflation, and productivity shocks) are detrended using the Hodrick–Prescott filter. The Bayesian estimation is based on the adaptive Metropolis–Hastings algorithm. The prior distributions of the estimated parameters are reported in Columns (4) and (5) in Table 3, and the posterior distributions are summarized in Columns (6)–(9). We use the means of the posterior distributions to study the IRFs of the relevant macroeconomic variables.

4.4 *Impulse Response Analysis*

Our IRF analyses focus on two shocks emanating from the agriculture sector: (i) a shock to agriculture productivity (supply shock) and (ii) a procurement and redistribution (demand-side shock). We discuss the estimated mechanisms of these shocks. The IRFs of each shock are benchmarked against a one-agent two-sector version of our model along the lines of Aoki (2001).[22] This allows us to highlight

22. To generate Aoki (2001) model as a special case of our model, the following parameter restrictions are imposed: $\mu_R = s_R = 1$, $\delta_p = \delta_R$, $\lambda = 0$, $\mu_A = \delta_R$, $\sigma_R = \sigma_P$, and an arbitrarily small value of $\phi = 1.000 * 10^{-25}$.

TABLE 3

Bayesian Estimation: Prior and Posterior Distributions

	Parameter	Density	Prior distribution		Posterior distribution			
			Mean	Std Dev	Mean	Std Dev	95% interval	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
s_R	SS Rich cons. share	IG	0.50	0.01	0.417	0.005	0.406	0.427
σ_R	Inverse of IES Rich	IG	1.25	0.14	1.142	0.132	0.897	1.407
σ_P	Inverse of IES Poor	IG	2	0.23	1.888	0.223	1.469	2.343
λ	SS share of subsidy in $C^P_{A,t}$	IG	0.2	0.01	0.259	0.003	0.253	0.264
ϕ	SS share of procured A good redistributed	B	0.8	0.06	0.804	0.056	0.686	0.903
φ	Inverse of Frisch elasticity of labor supply	IG	3	0.73	2.434	0.464	1.674	3.522
	Monetary Policy							
ϕ_r	Interest rate smoothing	IG	0.66	0.09	0.99	0.003	0.994	1.005
ϕ_π	Weight on inflation gap	IG	1.2	0.4	1.051	0.354	0.580	1.966
ϕ_y	Weight on output gap	IG	0.5	0.19	0.510	0.200	0.255	1.025
	Shocks: Persistence							
ρ_{A_A}	Productivity shock in A-sector	B	0.25	0.11	0.255	0.106	0.087	0.490
ρ_{A_M}	Productivity shock in M-sector	B	0.95	0.03	0.951	0.033	0.865	0.994
$\rho_{Y^P_A}$	Procurement shock	B	0.43	0.08	0.474	0.081	0.316	0.634
ρ_ϕ	Redistribution shock	B	0.59	0.09	0.694	0.066	0.561	0.816
	Shocks: Standard Deviations							
σ_A	Productivity shock in A-sector				0.016	0.0003	0.016	0.017
σ_M	Productivity shock in M-sector				0.015	0.0001	0.014	0.015
$\sigma_{Y^P_A}$	Procurement Shock				0.0196	1.16x 10^{-5}	0.0196	0.0196
σ_ϕ	Redistribution Shock				0.011	0.001	0.011	0.014
σ_υ	Monetary Policy				0.009	0.0001	0.009	0.010

Note: (a) 95% credible interval is reported in Columns (8) and (9). (b) Distributions include Beta (B), Inverse Gamma (IG), and Std Dev for standard deviation. (c) Inverse Wishart is used as the conjugate prior for the covariance matrix (identity matrix as scale matrix and d.o.f. = 100) of a multivariate normal distribution with unknown mean and covariance matrix.

the importance of having rich and poor agents and redistributive policy shocks to interact in the model. Throughout the IRF analyses, our focus is on understanding how these shocks affect sectoral and aggregate inflation rates, consumption of rich and poor agents, and resource allocation across sectors.

We allow for the procurement wedge to be positive, that is, $\mu_A - \bar{\delta} > 0$, and $\lambda > 0$.[23] Also, since $\delta_p > \delta_R$, this implies that the share of agricultural consumption by the poor (out of total poor consumption) exceeds the share of agricultural consumption by the rich (out of total rich consumption), which influences the impact effect of the shock on poor and rich agricultural consumption.

4.4.1 Transmission of a single period positive productivity shock in the A-sector. The IRFs in our model correspond to the red dash-dotted line in Figures 1–3. A positive productivity shock raises output and causes deflation in the agriculture sector (P_A falls). As a result, the TOT, T, falls. The price effect dominates the productivity ef-

23. We drop subscripts (t) and hats from variables for the following discussion to economize on notation. The IRFs for variables should be interpreted as their log deviations.

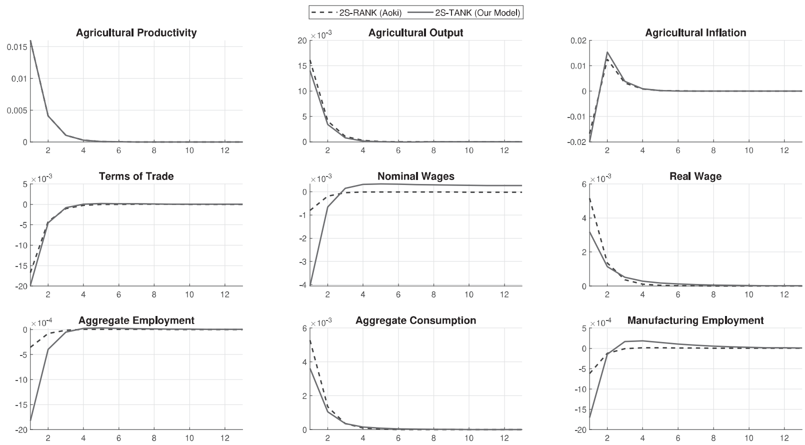

Fig. 1. Impact of a Single Period Positive Agriculture Productivity Shock.

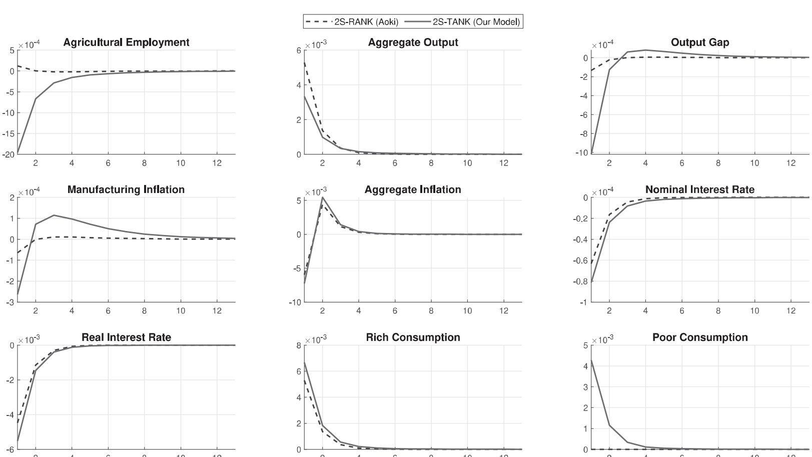

Fig. 2. Impact of a Single Period Positive Agriculture Productivity Shock.

fect of the shock, leading to a reduction in nominal wages. However, the aggregate price index falls by more than the nominal wage, leading to an increase in the real wages on impact. The income effect of real wage dominates the substitution effect, leading to an increase in consumption and a reduction in labor supply by both agents. As T falls, the manufacturing good becomes relatively expensive, resulting in a reduction in the demand for the manufacturing (M) good by both agents. Manufacturing output and employment decline.[24] While aggregate output increases, the output gap

24. In Aoki (2001), there is a much greater increase in demand for the agriculture good, inducing an increase in employment in the agriculture sector.

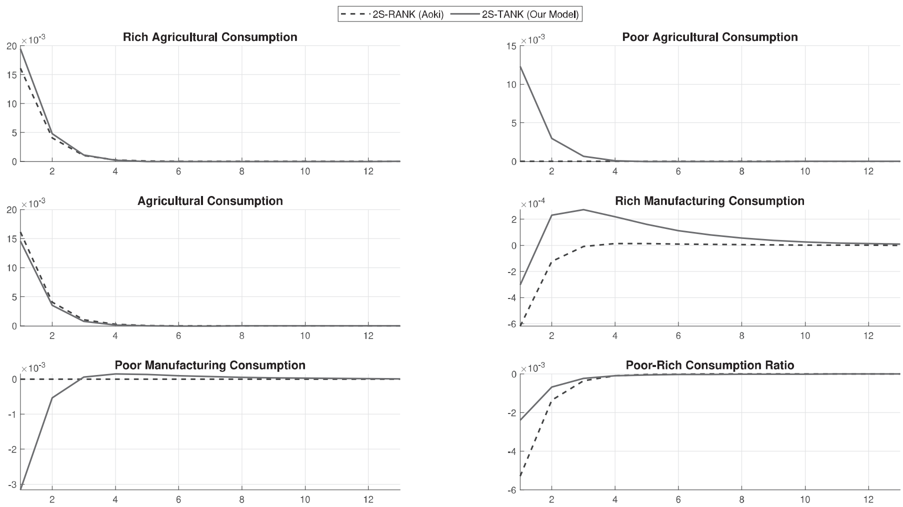

Fig. 3. Impact of a Single Period Positive Agriculture Productivity Shock.

falls.[25] There is a deflation in the manufacturing sector consistent with the negative output gap. Aggregate inflation falls because inflation in both sectors falls.

The decline in inflation and output gap induces the monetary authority from the Taylor rule, equation (51), to cut nominal interest rates. Real rates also fall since prices are sticky, which induces a rise in the consumption of rich households, C_R, because of the intertemporal substitution effect. From equation (42), it is apparent that the impact of poor household consumption, C_P, depends positively on C_R and the TOT. Overall, C_P rises, leading to aggregate consumption, C, to rise. In sum, a positive agriculture productivity shock leads to a rise in both poor and rich consumption, aggregate consumption, lower sectoral inflation rates, and lower aggregate inflation.

Distributional Impact. Both the rich and the poor benefit from higher real wages because of a positive productivity shock. This induces both sets of households to increase their consumption of both manufacturing and agricultural goods. The decline in the TOT (P_A falls relative to P_M) induces both the rich and poor to increase their demand for the agriculture good and to lower their demand for the manufacturing good. The TOT effect dominates so that agricultural consumption rises and manufacturing consumption decreases on impact. These are also shown in Figure 3. However, poor consumption increases less relative to rich consumption, suggesting that the rich gain more than the poor, shown by the falling poor-rich consumption ratio.

25. This happens because while output increases, the natural level of output increases even more. Under flexible prices, the decline in demand (in response to the agricultural productivity shock) would have led to lower prices in the manufacturing sector and, consequently, relatively higher manufacturing output.

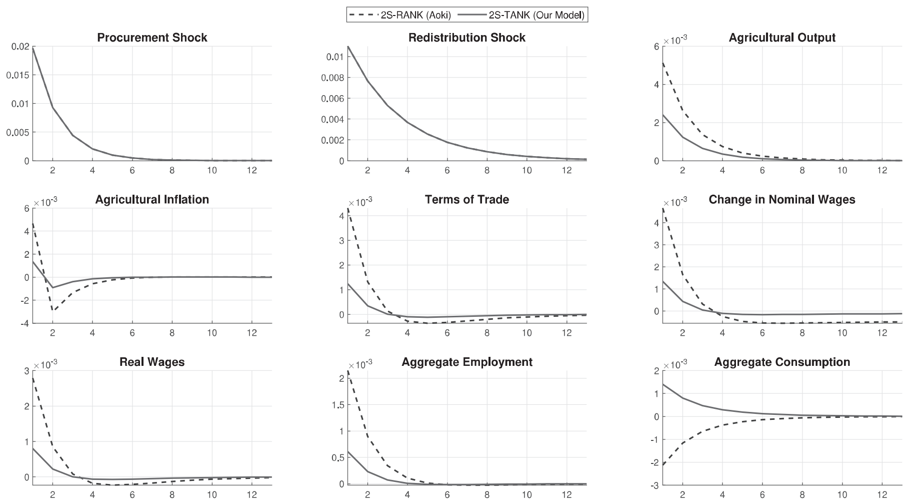

Fig. 4. Impact of a Single Period Positive Procurement and Redistributive Policy Shock.

NOTE: The figure shows the impulse responses to 2S-RANK (dashed lines) and 2S-TANK (solid lines).

4.4.2 Transmission of a single period redistributive policy shock. As before, a redistributive policy shock refers to a procurement and redistributive shock.[26] We first describe what happens in our (2S-TANK) model. This corresponds to the red dash-dotted line in Figures 4–6. A procurement and redistribution (which are orthogonalized) shock acts like a demand shock to the economy.[27] On impact, such a shock leads to higher demand for agricultural output, Y_A, higher P_A and, therefore, higher π_A. This also leads to an *increase* in the TOT, T. For the supply of agriculture goods to increase with no change in productivity, employment in the agriculture sector, N_A, must go up on impact. To attract labor to the agriculture sector, nominal wages in the agriculture sector must rise. With sticky prices in the manufacturing sector, equilibrium in labor markets (the same nominal wage in both sectors) means that economy-wide real wages rise.[28]

As before, a rise in real wages has two competing effects: income and substitution effects. The income effect states that a rise in the real wages (income) would lead to greater consumption of both consumption and leisure (C rises, N falls). In contrast,

26. We use these terms interchangeably.

27. The reason why we consider them simultaneously is that the government's desire to increase procurement is driven by its desire for higher redistribution.

28. This is broadly in line with research on the Indian National Food Security Act in 2013, which shows that changes in the generosity of the Public Distribution System led to higher wages, suggesting that labor market effects of social transfers bestow important additional effects in terms of benefits for the poor. See Baylis, Crost, and Shrinivas (2019).

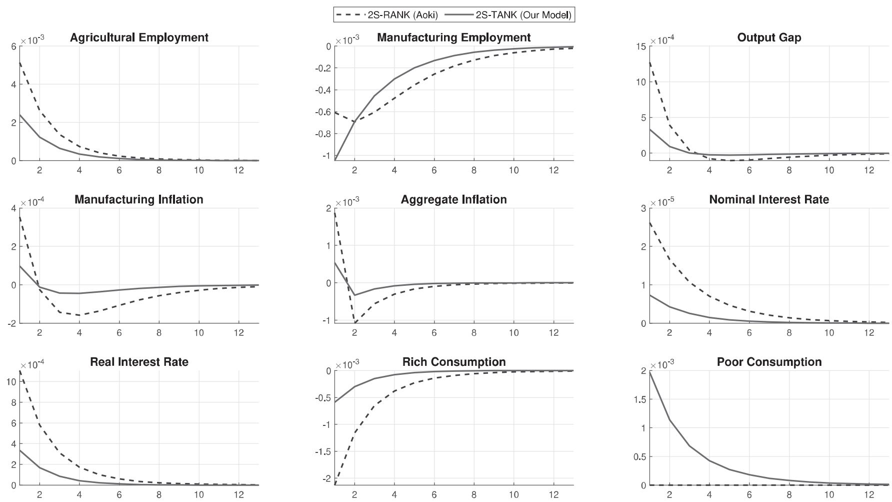

Fig. 5. Impact of a Single Period Positive Procurement and Redistributive Policy Shock.

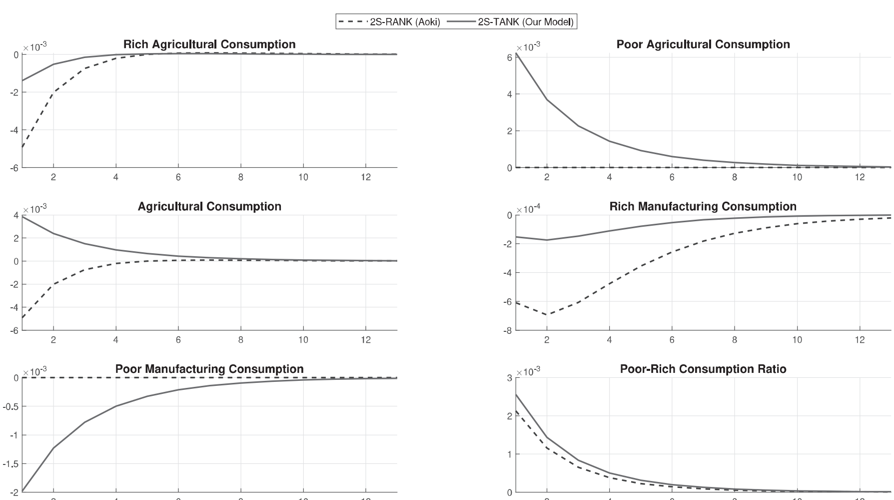

Fig. 6. Impact of a Single Period Positive Procurement and Redistributive Policy Shock.

the substitution effect states that a rise in real wages makes leisure relatively more expensive and hence leisure falls and consumption rises (C rises, N rises). The rich agent's consumption is governed by a third effect—the intertemporal consumption substitution effect, which states that an increase in the real interest rate will induce agents to save today and consume tomorrow, that is, substitute today's consumption for future consumption.

As the poor agents do not have access to financial markets—they cannot smooth their consumption over time.[29] The redistributive policy shock lowers the effective price of the poor agent's consumption basket. More precisely, it lowers the price of the agricultural goods paid by the poor agents to $P_A(1-\lambda)$, which turns out to be lower than P_M. This leads to an increase in C_P, $C_{P,A}$ and a decrease in $C_{P,M}$.[30]

As π_A is positive and current and future marginal costs of production are positive, manufacturing and aggregate inflation also increase on impact. Under flexible prices, manufacturing prices rise in response to higher real wages. This causes a smaller reduction in manufacturing output relative to the flexible price level of output, leading to a positive output gap. Given this, central banks must raise nominal interest rates. With sticky prices, real interest rates also rise on impact. Given our parameters, we find that aggregate consumption C rises, leading to higher welfare, even though monetary policy has tightened the interest rate.

Distributional Impact. As can be seen in Figure 6, consumption of both agriculture and manufacturing goods by the rich falls due to intertemporal substitution. However, a rise in agricultural consumption by the poor on impact leads to a rise in overall agricultural consumption. Poor manufacturing consumption, however, also falls because $P_A(1-\lambda)$ is lower than P_M. Unlike the previous case, C_P rises relative to C_R despite the central bank tightening interest rates.

There are interesting differences compared to Aoki's model (green dashed line).[31] In the Aoki (2001) model, all agents are rich (Ricardian) and do not have access to subsidized consumption of the agriculture good. Employment in our model, like before, is lower compared to Aoki (2001) because of the presence of poor agents who have a lower IES. The difference in the expenditure share of the agriculture good by the poor, $(\delta_p > \delta_R)$, plays an important role in the rich-poor consumption dynamics. Since the poor receive the redistributed agriculture goods for free, their demand for market purchases of the agriculture good is lower (Figure 4). As a result, aggregate demand for agricultural output is lower, and the impact effect of a procurement and redistributive shock on the agricultural output in our model is less compared to the Aoki model. Correspondingly, a procurement and redistributive shock leads to lower inflation on impact in our model compared to Aoki's model. As a result, the corresponding rise in the real interest rate from the Taylor rule is lower in our model, which implies that the decline in rich consumption is lower in our model compared to Aoki. Importantly, because of the redistributive shock, poor consumption

29. Motivated by consumption inequality in India, Lahcen and Gomis-Porqueras (2021) build a monetary model with endogenous credit market participation where the poor, because they do not have access to financial services, smooth their consumption by saving through fiat money. They find that the transmission of monetary policy changes substantially with this feature.

30. When we only do a procurement shock and set $\lambda = 0$, *both* C_P and C_R fall. Thus, the redistributive effect determines the consumption of the poor agent.

31. We have imposed $\mu_A > \delta_R$ to generate these IRFs. There is no redistribution, and, therefore, no redistributive policy shock in his model. The only shock, therefore, is a procurement shock.

rises in our model, offsetting the decline in rich consumption, and raising aggregate welfare.

4.4.3 Transmission Mechanism of a Monetary Policy Shock. We consider a single-period, contractionary monetary policy shock, which increases the nominal interest rate. This exercise is included to emphasize how our two-sector TANK model leads to a muted impact (less monetary transmission) compared to a variety of benchmarks—the simple NK model Galí (2015), Aoki (2001), and Debortoli and Galí (2024). We show that monetary policy has both output effects *and* redistributive effects. The key insight is that, under a monetary policy shock, the model's dynamics are driven more by the presence of two sectors—specifically, the inclusion of a flexible-price sector—than by demand-side heterogeneity introduced through poor agents. Section A.1.5 in the Online Appendix provides a detailed discussion.

4.5 Extensions

We consider three extensions to the baseline model.[32] First, we study the implications of redistributive policy shocks in a scenario where labor is immobile across sectors. (See Section A.1.6.1 in the Online Appendix for a detailed discussion.) We find that the impact on real and sectoral inflation rates, employment, and output is amplified. While these results are consistent with the baseline 2S-TANK model, the amplified effect of the shock leads to a stronger monetary policy response.

In the second extension, we allow for nonhomothetic preferences. We allow for subsistence consumption in agriculture for the poor. This changes the consumption index given in equation (4) to

$$C_{P,t} = \frac{(C_{P,A,t} - C_{P,A}^{subs})^{\delta_P} C_{P,M,t}^{1-\delta_P}}{\delta_P^{\delta_P}(1-\delta_P)^{1-\delta_P}}, \tag{52}$$

where $C_{P,A}^{subs} > 0$ is the subsistence level of agricultural consumption of the poor. Model simulations indicate that the log deviations from the steady state exhibit a similar qualitative pattern as in the baseline model. However, the immediate impact of the shocks is larger in the version using the standard index (as defined in equation (4)), due to lower steady-state values. (See Section A.1.6.2 in the Online Appendix for more information.)

Finally, in the third extension, we vary the employment shares to see whether the effectiveness of monetary policy is higher in economies where the employment share in the agriculture sector is smaller. We find that a higher share of the manufacturing sector leads to greater output adjustment and enhances the effectiveness of monetary policy. This insight applies to all EMDEs with large agriculture sectors, and offers a possible explanation for why monetary policy is ineffective in such economies. Refer to Section A.1.6.3 of the Online Appendix for more details.

32. For these extensions, we limit our comparisons to the baseline 2S-TANK model.

5. WELFARE

Following Schmitt-Grohe and Uribe (2007), we characterize the optimal monetary policy in the 2S-TANK model with the procurement and redistribution shock by using two approaches: (i) we assume that the monetary authority acts like a utilitarian Ramsey Planner and maximizes the weighted average of rich and poor welfare functions (53) subject to the private sector optimality conditions and the economy's feasibility constraints; and (ii) by computing optimal values of Taylor Rule parameters (or OSRs) that maximize economy-wide welfare via minimizing variances of inflation and the output gap. We compare the optimized simple rules with the planner's solution to see how well a monetary authority following OSR can implement the planner's solution.

The Ramsey-monetary authority maximizes, W_t, given by

$$W_t = \Omega W_{R,t} + (1 - \Omega) W_{P,t}, \tag{53}$$

where $W_{R,t}$ and $W_{P,t}$ are the lifetime welfare of the rich and poor agents, respectively.[33] The parameter $\Omega \in [0, 1]$ is the weight given to rich agents by the planner. This yields ROMP.

5.1 Criterion

For each agent $K \in \{R, P\}$, we define the welfare measure under a monetary policy regime a to be its expected lifetime utility at time 0 as $V^a_{K,0}$:

$$V^a_{K,0} \equiv E_0 \sum_{t=0}^{\infty} \beta^t \left[\frac{{C^a_{K,t}}^{1-\sigma_K}}{1-\sigma_K} - \frac{{N^a_{K,t}}^{1+\varphi}}{1+\varphi} \right]. \tag{54}$$

To compare welfare across regimes, we compute the *percentage* of steady- state consumption that agent K would like to give up to avoid the volatility from a shock under regime a.[34] Improvements in welfare are converted into consumption equivalent welfare gains (see Lucas 1987, Schmitt-Grohe and Uribe 2007 and Lubik and Teo 2009).[35]

33. The parameter $\Omega \in [0, 1]$ is the weight given to rich agents by the planner. Note that $W_{K,t} = U(C_{K,t}, N_{K,t}) + \beta E_t W_{K,t+1}$ for each $K \in \{R, P\}$.

34. We compute expected lifetime utility conditional on the initial state being the deterministic steady state using the nonlinear version of the model with Dynare 5.2.0.

35. Rubio and Carrasco-Gallego (2014) also compute consumption equivalents separately in terms of borrowers and savers to assess the importance of macro-prudential policy on financial stability.

Thus, the consumption equivalent χ_K can be computed from:

$$\sum_{t=0}^{\infty} \beta^t \left[\frac{[(1 - \frac{\chi_K}{100})C_K]^{1-\sigma_K}}{1-\sigma_K} - \frac{{N_K}^{1+\varphi}}{1+\varphi} \right] = V_{K,0}^a. \tag{55}$$

This definition captures the notion that business cycles are costly and risk- averse agents would be willing to pay (in consumption units) to avoid fluctuations in consumption.

5.2 Analysis

As the focus of our paper is on interventions in the agriculture sector, we focus on optimal monetary policy under redistributive policy shocks. We quantify consumption equivalents for agricultural productivity shocks for comparison (see Section A.3 in the Online Appendix for details).

Our main results are presented in Table 4. We find that OSR features a no-smoothing interest-rate, an aggressive response to inflation, and a muted response to output. The inflation coefficient of the optimized rule takes the largest value allowed in our search, namely, $\phi_\pi = 3$.[36] We also find that the optimized rule is quite effective as it delivers welfare levels remarkably close to those achieved under the Ramsey policy as evident by the low values of χ_K (for both conditional and unconditional welfare). While the planner is able to achieve lower sticky price inflation ($\sigma_{\pi_M} = 0.038\%$), which is close to full core-inflation stabilization, under OSR, aggregate inflation variability, σ_π, is lower. This is because under OSR, the monetary authority places a high weight on minimizing the variance of inflation. The planner is able to achieve lower volatility in the interest rates via commitment. Compared to the estimated Taylor Rule parameters in equation (50) from the Bayesian exercise in Section 4.3, we find that under OSR, the monetary authority is able to stabilize inflation more effectively (0.944% versus 0.169%) and the output gap (0.701% versus 0.128%).

The positive consumption equivalents suggest that conditional and unconditional welfare are higher under Ramsey than in alternative monetary policy regimes (OSR, simple Taylor rule, and the standard Taylor rule). Compared to OSR, both standard and simple Taylor rules yield higher consumption equivalents for both rich and poor households when either conditional or unconditional welfare is considered. In general, we find that consumption equivalents are substantially higher under nonoptimized rules for both rich and poor households compared to OSR, implying high

36. As the optimized rule features no interest-rate inertia, there is no difference in long-run impact of monetary policy. This is a result of the Taylor Rule specification and no persistence of the monetary policy shock. Relaxing these two allows for a significant long-run impact of inflation on interest rates as in Schmitt-Grohe and Uribe (2007).

TABLE 4

Optimal Monetary Policy for a Procurement and Redistribution Shock

Rule	ϕ_r	ϕ_π	ϕ_y	Welfare Cost	$\sigma_\pi(\%)$	$\sigma_{\pi_M}(\%)$	$\sigma_R(\%)$	$\sigma_{\tilde{Y}}(\%)$
Ramsey	—	—	—	$\chi_R^c : 0,\ \chi_P^c : 0\ \chi_R^u : 0,\ \chi_P^u : 0$	0.241	0.038	0.224	0.155
OSR	0	3	0	$\chi_R^c : 0.0035,\ \chi_P^c : 0.0024\ \chi_R^u : 0.0037,\ \chi_P^u : 0.0027$	0.169	0.122	0.517	0.128
Nonoptimized Rules								
Bayesian	0.9	1.05	0.51	$\chi_R^c : 0.5140;\ \chi_P^c : -0.248,\ \chi_R^u : 0.1105,\ \chi_P^u : -0.006$	0.942	0.404	0.083	0.699
Simple Taylor Rule	0	1.5	0	$\chi_R^c : 0.0177,\ \chi_P^c : 0.0106\ \chi_R^u : 0.0185,\ \chi_P^u : 0.0120$	0.384	0.261	0.586	0.298
Standard Taylor Rule	0	1.5	0.5	$\chi_R^c : 0.0879,\ \chi_P^c : 0.0514\ \chi_R^u : 0.0929,\ \chi_P^u : 0.0587$	0.712	0.568	0.880	0.498

Note: Conditional and unconditional welfare costs are $\chi^c \cdot 100$ and $\chi^u \cdot 100$, respectively. In this table, they are defined as the percentage decrease in the Ramsey-optimal consumption process necessary to make the level of welfare under the Ramsey policy identical to that under the evaluated policy. Thus, a positive figure indicates that welfare is higher under the Ramsey policy than under the alternative policy. The value of ϕ_r is set to 0.9 to prevent explosive paths in second-order simulations.

welfare costs associated with redistributive policy shocks when nonoptimized rules are used in setting monetary policy.[37]

To assess the impact of redistribution on welfare costs, we fix the steady-state amount of agricultural output procured and vary steady-state redistribution ($\phi = 0.40$ and $\phi = 0.80$). These results are described in Online Appendix A.3. We show that the volatility of poor consumption rises when the steady-state redistribution in the economy rises.[38] We conduct a similar exercise using OSR. As poor agents are risk-averse and unable to smooth consumption, they have higher consumption equivalents across both regimes. Therefore, they are willing to forgo a greater amount of their steady-state consumption to avoid fluctuations in consumption.

5.3 Sensitivity Analysis

We check for the robustness of our results by altering the weights in the social planner's objective function. These results are reported in Table A.8 in the Welfare Online Appendix A.3.3. We contrast the case of a Ramsey planner (i) who only values the Ricardian agents' welfare (i.e., sets $\Omega = 1$ in equation (53)) and (ii) with a planner who only values the poor (i.e., sets $\Omega = 0$ in equation (53)). We find that placing a zero-weight on the utility of financially constrained agents makes the planner come closer to full inflation stabilization ($\sigma_\pi = 0.129\%$), which is a superior to a monetary authority following OSRs (see Table 4, $\sigma_\pi = 0.169\%$). Thus, the relative weights assigned to the utility of the rich and the poor in the planner's objective function determine the extent to which full inflation stabilization is achieved.[39]

6. CONCLUSION

Governments in many EMDEs routinely intervene in their agriculture markets because of changing food security norms or to minimize food price volatility. Such interventions typically involve higher procurement and redistribution of food commodities, and higher food subsidies by the government to households. This paper asks: what is the impact of a procurement and redistributive policy shock on the sectoral and aggregate dynamics of inflation, and the distribution of consumption among rich and poor households?

37. The negative consumption equivalent using the Taylor Rule with parameters estimated from Bayesian methods for both conditional and unconditional welfare for the poor reflects the high steady-state consumption of poor households in the Bayesian regime. This result is independent of the weights given by the planner in equation (53). Bayesian estimated rules lead to the most aggregate inflation volatility.

38. This is on account of higher variability of subsidy (λ_t) with higher steady-state redistribution.

39. We also perform a sensitivity analysis for OSR by reversing weights on aggregate inflation and the output gap in the loss function (see Table A.9 in the Online Appendix). We find that the Taylor rule parameters under OSR are unaltered for a procurement and redistribution shock.

To address this, we build a two-sector (agriculture and manufacturing) two-agent (rich and poor) New Keynesian DSGE model with redistributive policy shocks. There are two novel aspects of our framework. First, we extend the framework of Debortoli and Galí to two sectors. Second, we allow for government intervention in the agriculture market in a way that captures the essence of procurement and redistribution style interventions in EMDEs. Our framework allows us to understand how redistributive policy shocks affect the economy, and the role of consumer heterogeneity on the welfare implications of a variety of shocks. Our paper contributes to a growing literature on understanding the role of consumer heterogeneity in analyzing the effect of monetary policy.

Using Indian data, we estimate the model using a Bayesian approach. We show that a redistributive policy shock leads to higher sectoral and aggregate inflation and higher aggregate consumption in the economy, even though there is a decline in the consumption of the rich. We compare our results to a variety of benchmarks to isolate the effect of adding a flexible price production sector or adding rule of thumb agents on the model's dynamics. We also show that our main results are robust to two major extensions: nonhomothetic preferences and immobile labor.

The welfare analysis allows us to quantify the welfare costs of redistributive policy shocks under alternative regimes when compared to ROMP. We show that when nonoptimized simple rules characterize monetary policy, the welfare costs are larger for both rich and poor households compared to OSRs.

Although our paper is set in the Indian context, it has general implications for EMDEs that are characterized by a relatively large agriculture sector and periodic government intervention to support the poor. While procurement and redistributive policies are often enacted to improve the welfare of the poor, our analysis sheds light on the general equilibrium effects of such policies, the welfare costs of such policies, and how a monetary authority should respond to them.

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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section at the end of the article.

Data S1