Distortions to Agricultural Incentives in India: Evidence from Agricultural Value Chains

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ABSTRACT

With growing population, increasing and still uneven income distribution, achieving food and nutrition security is a critical goal for the Government of India (GOI). GOI implements a wide range of agricultural, trade, and domestic policies to achieve this goal, creating a highly regulated environment for consumers and producers. At the same time, there are new policies, such as biofuels market policies, that create new value chains and new income opportunities for the farmers. Income growth leads to higher consumption of vegetable oils and livestock and dairy products, creating higher value added for oilseeds producers by generating larger markets for by-products. This complicated policy environment affects both the producer and the consumer decisions across the entire value chain. In this context, it is crucial to identify which parts of agricultural distortions in India are due to market failure and which parts are due to effective policy intervention. Agricultural distortions, originating from either policy design or other sources, also create and influence value chains within a country. Therefore, measuring distortions along the complete agricultural value chain is necessary for effective policy design. The *objective* of the paper is to measure the impact of sector-specific and state-specific policies on agricultural incentives in India across agricultural value chains. Specifically, we focus on two value chains: oilseeds value chain (rapeseed and groundnut complex) and biofuels value chain (ethanol-molasses-sugar-sugarcane complex). We utilize state level price data at different points in the market to measure distortions to agricultural incentives at state level for the primary commodities in these value chains and for the entire value chain. The results show that GOI has effectively protected the farmers for the primary commodities included in this analysis. When a primary commodity is part of a value chain that generates additional products through processing, the effective NRPs for the farmers producing the primary commodity increase. This is due to two channels: first farmers receive higher prices for their crop since there is additional value being generated through a larger market. Second, protection of these processed commodities and their higher prices are transmitted to the primary commodity prices. Measuring distortions along the entire value chain are therefore necessary for effective policy design and evaluation.

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1. Introduction

With growing population, increasing GDP, and uneven income distribution, achieving food security is a critical goal for the Government of India (GOI). GOI implements a wide variety of policies to achieve this goal (agricultural trade, energy, domestic, etc.), creating a highly regulated environment with overlapping policy impacts and outcomes. At the same time, there are new policies, such as biofuels policies, that create new value chains and new income opportunities for the farmers. Income growth leads to higher consumption of vegetable oils, livestock and dairy products, creating higher value added for oilseeds producers by generating larger markets for their by-products (meal and oil). This complicated policy environment affects both the producer and the consumer decisions across the entire value chain.

ERS USDA defines value chain (or supply chain) as "network of firms that bring products to market, from companies that produce raw materials to retailers and others that deliver finished products to consumers. Economic value is added through the coordinated management of the flow of physical goods and associated information at each stage of the chain". OECD (2013) describes value chain as a full range of activities by firms to bring a product to market from conception to final use, including design, production, marketing, logistics, and distribution in these activities.

In India, ethanol is made from molasses (a by-product of sugar production from sugarcane) and very closely linked to sugar market developments. Ethanol is the dominant biofuels sector, with biodiesel market remaining insignificant. As for all agricultural feedstock based biofuels, it is not possible to separate the two markets and their policy structure. GOI has introduced legislation to support development of biofuels sector such as continuous support for ethanol blending with gasoline through blending targets, procurement price schemes, and reduction of tariffs and taxes.

This complicated policy environment affects both the producer and the consumer decisions across the entire value chain. In this context, it is crucial to identify which parts of agricultural distortions in India are due to market failure and which parts are due to effective policy intervention. Agricultural distortions, originating from either policy design or other sources, also create and influence value chains within a country. Therefore, measuring distortions along the complete agricultural value chain is necessary for effective policy design.

The *objective* of the paper is to measure the impact of sector-specific and state-specific policies on agricultural incentives in India across entire value chains. Specifically, we focus on two value chains: oilseeds value chain (rapeseed and groundnut complex) and biofuels value chain (ethanol-molasses-sugar-sugarcane complex). We utilize state level price data (2008/09 through 2011/12) at different points in the market to measure distortions to agricultural incentives at state level for the primary commodities in these value chains and for the entire value chain. We are not only interested in NRP for inputs and NRP for outputs, but also how NRPs that a farmer faces change with the existence or creation of a value chain. For this, we need to compute NRPs for a complete value chain and we need to find a mathematical expression for this NRP.

We mainly rely on the methodology for NRP from Krueger, Schiff, Valdes (1988) to measure distortions to agricultural incentives. At the same time, we need to measure the combined impact of policies on the primary commodities and the complete value chain. To this end, we also utilize the methodology description from Anderson et al. (2008) for computing transmission of assistance/taxation along the value chains and the input-output NRA discussion.

Our results show that GOI has effectively protected the farmers for the primary commodities included in this analysis, specifically sugarcane, sugar, groundnut, and rapeseed producers. When a primary commodity is part of a value chain that generates additional products through processing, the effective NRPs for the farmers producing the primary commodity increase. This is due to two channels: first farmers receive higher prices for their crop since there is additional value being generated through a larger market. Second, protection of these processed commodities and their higher prices are transmitted to the primary commodity prices. We find that adding molasses and ethanol value chains to sugar-sugarcane value chain has increased final NRPs that the producers of sugar-sugarcane received. This NRP increase was achieved by legislation such as ethanol blending mandates and creating a new market for sugarcane. We also find that computing the NRPs throughout the complete oilseeds value chain (rapeseed, rapeseed meal, rapeseed oil) (groundnut, groundnut meal, groundnut oil) rather than NRPs for only seed and nut gives the correct and higher NRP for these farmers.

2. Indian agricultural policy environment

The Indian agricultural sector is heavily regulated both at federal and at state level. GOI is heavily protective of the agricultural sector, and much of this comes from the desire to be self-sufficient and to protect the farmers from international market volatility. At the same time, it is also protective of the poorer segment of the consumers and has in place one of the largest public distribution systems in the world for food grains. What results is a large number of policies to protect both groups and in many markets.

Most recently, the National Food Security Bill (NFSB) of 2013 was put in place to reform the existing Public Distribution System (PDS) and expand its outreach. NFSB is geared towards expanding food security for a wider range of households. Its focus on food grains implies that a larger stock of food grains will be purchased by the Food Corporation of India (FCI) than before.

On the agricultural input side, fertilizer producers get access to subsidized natural gas. The government also subsidizes key inputs for the farmer such as fertilizer, electricity, and irrigation. The rates of which differ by state and by commodity as well as by the intensity of input. The largest subsidies are those on fertilizers and take up a large part of the government expenditure. Beyond subsidizing the fertilizer producer, a farmer sees a flat price for fertilizer for nitrogen based urea. For phosphate and potassium based fertilizer, there is a per kilogram subsidy in place as well. There are also subsidies on the provision of irrigation water and canal water as well as subsidies on power used for drawing up groundwater. Punjab provides irrigation water free of charge, other states subsidize based on crop or growing season. Subsidy to irrigation water covers losses incurred by government irrigation systems.

Minimum Support Price is one critical supply side tool used by the GOI to support farmers' incomes and reduce the volatility of the supply. This price is announced by the GOI before planting and is based on recommendations from the Commission of Agricultural Costs and Price (CACP) and farmers have the option to sell their produce either to the government or on the open market. The list of agricultural commodities covered include rice, wheat, maize, coarse cereals, pulses, cotton, groundnut, including sugarcane which is handled slightly differently through the Fair and Remunerative Price. This generally protects against excessive fall in price during bumper production years or a fall in international prices. For those crops that are not covered by the Minimum Support Price, there exists a Minimum Intervention Price.

This supply side protection goes hand in hand with the Public Distribution System, where the government entity the Food Cooperation of India purchases rice, wheat, and some coarse grains in order to distribute subsidized food to the poor (for which the FCI uses Central Issue Prices for distribution). The categorization is in three income groups of poverty lines, above (APL), below (BPL), and extremely poor (AAY). The FCI also purchases grain in order to build up a buffer stock in case of shortage.

For the special case of sugarcane, instead of a Minimum Support Price, there exists the policy of Fair and Remunerative Price (FRP). Here the FRP is the price that the sugarcane millers have to pay the farmers for sugarcane, rather than there being a procurement system through the government. It is also known as the Statutory Minimum Price (SMP). Moreover, beyond the FRP, some individual states issue minimum prices for sugarcane that they recommend that mills pay to farmers. Where enforced, this State Advised Prices (SAP) is higher than FRP/SMP. The SAP is enforced in Punjab, Bihar, Haryana, Uttar Pradesh, Madhya Pradesh and Rajasthan (not connected to recovery rates), Karnataka, Tamil Nadu and Andhra Pradesh (connected to recovery rates), and Maharashtra and Gujarat (cooperative dominated; low SAP but profit sharing with the mills) and varies from state to state and is not a straight calculation by weight.

There are policies on the sugar market at every step of the value chain, from downstream sugarcane production to end market products. Molasses, one of the by-products of producing sugar, the other being bagasse, is also under policy constraints by the government regarding its uses. Here the government dictates the proportion of molasses that may be used for the production of alcohol versus alternative products such as feed and ethanol production. The current policy allocates 70% of molasses to alcohol production that leaves 30% for other uses although this ratio differed in the past. Another policy is that of the catchment area, where mills are required to purchase all sugarcane delivered to them from within a command area and need permission from the government to purchase sugarcane from outside this area, command areas usually range from 15 km to 80 km. In addition, sugar mills must maintain a distance of at least 15 km from each other. These policies have shaped how sugarcane farms as well as mills are located.

On the processed sugar side, there are more policies. One of these was the sugar levy: since there is no procurement of sugar as there is with wheat and rice, sugar mills were required to supply a certain percentage of their output (10% since 2002 to 2012) to the government at a set low price. This levy sugar was then distributed to consumers through the PDS to those who are below the poverty line at a uniform price set by the government. The rest of the sugar was free to be sold on the open market. Obligatory supply of sugar as levy on the mills was done away with for sugar produced after September 2012. The requirements for the Public Distribution System are now procured through open market.

For ethanol production, at various times there has been a ban on directly producing ethanol production from sugarcane juice in order to prevent direct competition between sugar and ethanol production. This was removed by Cabinet Committee on Economic Affairs in 2007. This policy was reinstated in 2013; however, since October 2014 there is allowance of procurement of ethanol from non-food feedstock such cellulosic.

Ethanol is also subject to a procurement price set by the Cabinet Committee on Economic Affairs over the years that sets the price that factories can sell to the blenders. This uniform purchase price for ex-factory ethanol had been Rupees 21.5/liter from 2006 to 2009. It was increased to Rupees 27/liter in 2010. This transitioned into a procurement price to be decided between OMCs (oil marketing companies) and ethanol suppliers in 2013. Price quoted by suppliers ranged from Rupees 38 per liter to Rupees 54 per liter in Calendar Year 2013. In 2014, the ceiling for benchmark price was set at Rupees 44 per liter, while ex-mill prices ranged from 33-46 per liter. Later the purchase price for ethanol was fixed to 48.5/liter, 49/liter, or 49.5/liter depending on distance of the mill from the supply depot.

Ethanol demand is driven by the ethanol blend mandate starting from 2003 which required that nine major sugarcane-growing states as well as four union territories have a 5% ethanol blend in gasoline. In 2004, the blend mandate was repealed due to sugarcane shortage, and rising alcohol and ethanol prices. In November 2006, the 5% blend mandate was enforced all over India except Jammu&Kashmir and some minor states and Union Territories. In 2007, 10% blending was made optional starting October 2007 to October 2008 and mandatory thereafter. In 2009, the Cabinet Committee on Economic Affairs set official target of 20% blending by 2017 for both ethanol and biodiesel. In 2010, a group was set up to ascertain the availability of ethanol and recommend the blend percentage in States and Union Territories up to a limit of 10%. In 2012, 5% blending was made mandatory effective from December 2012 across all India. It should be noted that while there have been policies made, the blend mandate has fallen short time and again, with ethanol blended petrol being in only 13 States with a blending level of 2% against the mandatory 5% in 2012. In 2015, the 5% target was still held but market penetration was predicted to reach 2.8% in Calendar Year 2015. All of this with the indicative target of 20% replacement of petroleum fuel consumption with biofuels by the end of 2017 as per the National Biofuel Policy Target.

Likewise, there are a number of trade restrictions in place that alter the Indian domestic market. All agricultural commodities are subject to basic and basic tariffs on imports that heavily discourage trade to protect the domestic market. For sugarcane, in 2010, the tariff on sugar imports was 30% basic and 150% on bound imports. Similarly, wheat and rice are subject to 100% and 80% bound rates respectively in 2015. India is usually a net exporter of rice and usually also exports wheat and sugar but tends to become an importer of both during shortage years during which it also tends to enforce export bans on certain commodities. Beyond these periods however almost all basic food commodities are freed from export restrictions.

Ethanol too is subject to a tariff rate, this rate was reduced from 7.5% to 5% in 2014. Ethanol blending with gasoline is also subject to federal central excise duty as well as states levy VAT, denaturation fee, entry tax, etc. Federal 12.36% central excise duty was removed for the 2015-2016 marketing year.

Overall, the Indian agriculture economy is highly regulated at almost all steps of the value chain for various agricultural commodities.

3. Previous Literature and Methodology

There is a wide literature and multiple institutional databases that measure distortions to agricultural incentives. World Bank initiated this with the Nominal Rate of Protection (NRP), and updated later to Nominal Rate of Assistance (NRA). OECD has continuing efforts with Producer Support Estimates (PSE) database. These methodologies measure indirect measurement of incidence, or direct measurement of policies (or a combination). However, heterogeneity in the methodologies and different data sets being used have made it difficult for policy makers to correctly measure and interpret the impact of their policy designs. We will give a brief summary of the previous efforts on this topic. Our literature review is not exhaustive, but attempts to cover main methodologies with key examples.

NRP estimates by Krueger, Schiff, and Valdes (1988) were the first major attempt to estimate the impact of direct sector specific and indirect economy-wide policies on agricultural incentives in various developing countries for the period of 1975-1984. While it had been known that protectionist activities for some sectors negatively discriminate against the rest of the sectors, before this paper, there had been no standardized way to measure this. They measure the direct effect of policies by the proportional difference between the producer price and the border price that has been adjusted for distribution, storage, transport, and other marketing costs. The indirect effect is measured in two parts: first, through the impact of the unsustainable portion of the current account deficit and of industrial protection policies on the real exchange rate and thus on the price of agricultural commodities relative to non-agricultural non-tradable commodities; second, through the impact of industrial protection policies on the relative price of agricultural commodities to that of non-agricultural tradable goods.

The authors note that developing countries tend to do four things in common in terms of policy implementations to encourage growth. First, these countries may try to encourage growth through import substitution and protection policies. Second, these countries may maintain overvalued exchange rates through exchange control regimes and import licensing mechanisms. Third, developing countries may attempt to suppress producer prices of agricultural commodities through different mechanisms such as procurement policies, export taxation, and export quotas. Finally, these countries may attempt to offset part of the disincentive effect on the producers by subsidizing input prices and investing in capital inputs.

To capture the net effect of these policies, the authors measure impact relative to prices that would have been in place had there been no interventions. To do this, they collect domestic producer prices, domestic consumer prices, and border prices. They adjust border prices for transportation cost to or from producer and consumer locations, storage costs, quality differences, or other elements of marketing margins to make them comparable. In other words, they compare like with like.

Let P_i denote domestic producer price, P_i^B denote border price, P'^*_i denote border price evaluated at the equilibrium nominal exchange rate, P'_i show border price at the official exchange rate, P_{NA} be price index of non-agricultural sector, E_0 be the official exchange rate, E^* be the equilibrium nominal exchange rate that has been adjusted for transport costs, storage costs, etc. In this case, authors define direct nominal rate of protection (NRP_d) and indirect nominal rate of protection as (NRP_i) as follows:

Eq 1 $P'_i = P_i^B \cdot E_0$

Eq 2 $NRP_d = \frac{P_i / P_{NA}}{P'_i / P_{NA}} - 1 = \frac{P_i}{P'_i} - 1$

Eq 3 $P'^*_i = P_i^B \cdot E^* = P'_i \cdot E^* / E_0$

Eq 4 $NRP_i = \frac{P_i / P_{NA}}{P'^*_i / P^*_{NA}} - 1 = \frac{P_i / P_{NA}}{P'_i \; E^* / E_0 \; / P^*_{NA}} - 1 = \frac{P^*_{NA}}{P_{NA}} \frac{E_0}{E^*} - 1$

The authors find that mostly the direct effect is equivalent to a tax on exportable goods and to a subsidy for importable goods. They also find that indirect effect too can be seen as a tax on agriculture tends to dominate the direct effect in magnitude.

Schiff and Valdes (1992) use the same methodology as Krueger, Schiff, and Valdes (1988), but use longer time periods (1960 to 1984) to look at trends in the NRP for the same eighteen countries. They find that in almost all countries, indirect interventions reduce agricultural incentives far more than direct interventions.

Anderson et al. (2006) expand this analysis by measuring NRA and outline the many methodological issues (output and input NRAs, transmission of prices along the value chain). This is done as part of the World Bank project to reduce poverty by reducing distortions to agricultural incentives. The authors note that most developing countries have policies in place that depress farm incomes. Similarly, policies in developed countries depress cash earnings of farm households in developing countries through increased output. They note that usually national objectives such as poverty alleviation may be achieved more efficiently though other more effective policies or in some cases even just the removal of current policies. The authors come up with a framework for measuring NRA and outline the many methodological issues with deriving such numbers. NRA_BS is the NRA to farm output conferred by border price support, while NRA_DS is the assistance conferred by the domestic price supports. S_f is the subsidy provided to farmers while t_m is a tariff. E is the exchange rate and P is the foreign currency price of the product on in the international market. Their methodology can be summarized as follows:

Eq 5 $NRA_{BS}: \frac{E \cdot P \cdot (1-t_m) - E \cdot P}{E \cdot P} = t_m$

Eq 6 $NRA_{DS}: \frac{E \cdot P \cdot (1-S_f) - E \cdot P}{E \cdot P} = S_f$

Eq 7 $NRA_{OUTPUT} = NRA_{DS} + NRA_{BS}$

The authors calculate an estimate of NRA to inputs, where each input's NRA is multiplied by its input output coefficient. Summed over all inputs, this becomes NRA_{INPUT}. This is then added to NRA on outputs to get total NRA.

Eq 8 $NRA_{TOTAL} = NRA_{INPUT} + NRA_{OUTPUT}$

The authors also break down the transmission of prices along the value chain, paying special attention to where prices are adjusted. This includes factoring in both international and domestic trading costs, domestic processing costs, as well as intermediary margins through wholesale and retail costs. The authors also must compensate for international trading costs when there is no or little trade due to lack of data. Quality adjustments must also be considered, as there may be a variety difference in export quality and domestic consumption goods. The authors discuss a number of issues such as having to account for non-exportable goods that may become exportable after processing. The authors also discuss the problems with having to classify products as importable, exportable, or non-tradable.

Pursell, Gulati, and Gupta (2007) look extensively into Indian agricultural sector and compute NRAs similar to the World Bank study. However, they extend it by covering 12 agricultural products, including milk, fruits and vegetables. They also expand the coverage years considerably to 1965-2005. As most commodities are non-traded or fluctuate in trade status, they used international prices instead of border prices. While the methodology is similar to Anderson at al. (2006), since most commodities have fluctuating trade status, they use international prices, when border prices are not available. Overall, the authors find a slight upward trend in the last forty years in the NRA for agricultural commodities in India. Secondly, NRAs for import competing products are higher than that of NRAs of exportable goods. Thirdly, there is a wide fluctuation in NRAs for goods from year to year. At the same time, prices for staples such as rice and sugar remain relatively stable, showing that the Indian government is actively implementing policies to achieve this. Fourth, different commodities have vastly different NRAs although this has been slightly decreasing since 1990 when reforms were put into place. Fifth, overall there has been a steady increase in in contribution to NRA mostly through subsidies for fertilizer, electricity, and water. However, this paper did not include NRA computations across agricultural value chains and rather focused on individual commodity NRAs.

OECD PSE database focuses on direct measurement of policies. Total Support Estimate (TSE) is an indicator of the annual monetary value of all gross transfers from taxpayers and consumers arising from policy measures that support agriculture, net of the associated budgetary receipts, regardless of their objectives and impact on farm production and income, or consumption of farm products. TSE is the sum of the explicit and implicit gross transfers from consumers of agricultural commodities to agricultural producers net of producer financial contributions through Market Price Support (MPS) and Consumer Support Estimate (CSE), the gross transfers from taxpayers to agricultural producers through Producer

Support Estimate (PSE), the gross transfers from taxpayers to general services provided to agriculture through General Services Support Estimate (GSSE), and the gross transfers from taxpayers to consumers of agricultural commodities though CSE. The OECD also has the metric Nominal Protection Coefficient (NPC) that includes budgetary outlays and treats input markets differently. NPC is the producer price relative to the reference price, with the unit value of payments based on output also included.

Eq 9 $$NPC = \frac{Producer\ Price + \left(\frac{Payment\ based\ on\ Output}{Quantity\ of\ Production}\right)}{Reference\ Price}$$

FAO-MAFAP (Monitoring and Analysing Food and Agricultural Policies) and IDB-Agrimonitor (Inter-American Development Bank) use methodologies developed by the World Bank and OECD respectively. MAFAP (2016) reports the Nominal Rate of Protection at the Farmgate and at the Point of Competition. For this, it uses the border price as before, but adds computation of the Reference Price at the Point of Competition and the Reference Price at the Farmgate by subtracting access costs between Border and Point of Competition and between Point of Competition and Farmgate respectively as well as implementing quality and quantity conversion factors where required.

Valdes and Foster (2011) calculate the Effective Rate of Protection (ERP) in the context of Egypt. ERP is the measure of the impact of border protection on an industry's net returns. This is based on the Value Added by a particular industry, measuring the percent deviation of an industry's value added on what it would be in the absence of protection covering both input and output side. The authors compare $ERPs$ over time, looking at 23 major sectors in the contemporary Egyptian market. They concentrate on calculating ERPs in the energy sector given that there are multiple sub-sectors that subsidize this sector. Their methodology is to first compute ERP with formal applied tariffs, and where possible add ad valorem price wedge introduced by nontariff barriers and energy subsidies. They also add energy subsidies in Egypt to ERP estimates. They formulize gross ERP as:

Eq 10 $$ERP_g = \frac{VA_{gross}}{VA_{gross}^{Hyp}} - 1$$

The authors show that, for Egypt, trade liberalization since the 90's has had a considerable impact in reducing the protection of certain industries however food and tobacco remain highly protected due to tariff escalation and NTBs as well as energy subsidies. They note that, while energy subsidies are not sector specific, they do tend to favor energy intensive sectors.

4. Methodology to measure distortions to agricultural incentives along a value chain

As discussed in Section 3 above, there are multiple methodologies used in the literature for measuring distortions to agricultural incentives. This paper relies on indirect measurement of incidence, i.e. price difference methodology. The focus is on nominal rate of protection (NRP) for producers (farmers in this case) first discussed by the seminal paper of Kruger, Schiff, and Valdes (1988). Direct NRP is formulated in this paper as

Eq 11 $$NRP = \frac{(Farmgate\ Price - Reference\ Price\ at\ Farmgate)}{Reference\ Price\ at\ Farmgate}$$

in this paper. Reference price is defined as the border price evaluated at the official nominal exchange rate adjusted for transport, storage, other costs, and quality difference to be made comparable to producer price. Producer price is the price earned by producers at the end of the value chain.

Anderson et al. (2006) expand this analysis with Nominal Rate of Assistance (NRA) discussion. In their paper, they provide a comprehensive discussion on the different components of these other adjustments mentioned in Kruger, Schiff, and Valdes (1988), i.e. the adjustments that are required to be made to correctly analyze and compute the price transmission when agricultural commodities move along the value chain. Anderson et al. (2006) outline the methodology for deriving such numbers in a comprehensive manner, especially in regards to policy. At the same time, they provide a detailed and intuitive discussion on how to measure distortions along the value chain. They first ask, "What if farm production involves not just primary factors but also intermediate inputs?" and discuss effective rate of direct assistance to farm value added. Second, they discuss non-distortionary price wedges and provide the categories for these adjustments to prices. Specifically, they list domestic trading costs, processor/wholesaler costs, international trading costs, and product quality/variety differences. Finally, they discuss "transmission of assistance/taxation along the agricultural value chain" where they write "… a crucial aspect of the NRA calculation for agricultural products is how any policy measure beyond the farmgate gets transmitted back to farmers and forward to consumers".

Our main objective in this study is to identify and analyze the price transmission along the value chain when there are by-products or processed goods are present, and to use this approach to compute NRPs for the whole value chain of a product, rather than the NRP for the main primary commodity. We are not only interested in NRP for inputs and NRP for outputs, but also how NRP's that a farmer faces change with the existence or creation of a value chain. For this, we need to compute NRPs for a complete value chain and we need to find a mathematical expression for this NRP.

These two studies, and many other studies based on these, emphasize the importance of the value chain due to different sources of price gaps: transportation, distribution, processing, and policies. We utilized the economic intuition of these studies and identified three concepts for us to base our methodology and analysis on.

4.1 Location of Measurement

The distortion to agricultural incentives is measured by comparing domestic prices (actual prices faced by the producer, farmgate harvest price in our case) and reference prices (free of influence from domestic policies' and markets) for a given agricultural commodity and a given location (point of competition or farmgate). In our analysis, we used three locations of measurement:

i. the border, where we use international prices
ii. the point of competition, where we use market prices
iii. the farmgate, where we use harvest prices earned by the farmers

4.2 Non-distortionary price wedges

The analysis in our study is based on the law of one price. Therefore, the prices must refer to goods that are comparable (in terms of quality, processing level, and location). Reference price is the border price evaluated at official nominal exchange rate adjusted for transport, storage, distribution, processing, and quality differences. Additionally, these adjustments allow us to exclude the non-policy driven distortions on prices and compute the NRPs correctly. It also allows us to incorporate the place of each commodity within the value chain complex and with respect to each other. This is crucial in our analysis since we compute NRPs of both primary and processed commodities and integrate them for the NRP of the complete value chain.

Between each location point identified above, we make three adjustments to make the prices comparable. These are quantity conversion, quality conversion, and marketing costs. In our case, marketing costs include sum of processing costs, transport costs, handling costs, taxes and fees, and other costs.[1]

4.3 Input-output coefficient

We also use input-output (I-O) coefficient data for primary and processed goods to generate NRPs for the complete value chain. First, the NRP for the primary commodity is computed, then the NRP for the processed commodity is computed at the *primary commodity equivalence* level taking into consideration I-O coefficients for each. Finally, NRP for the whole value chain is computed by adding $NRP_{Primary}$ and $NRP_{Processed}$. These will be discussed in detail below for each value chain separately.

One critical assumption that we are making is assuming 100% pass-through of all additional profit from the upstream parts of the Value Chain to farmers. This is due to lack of access to data and we intend to address this issue in the near future.

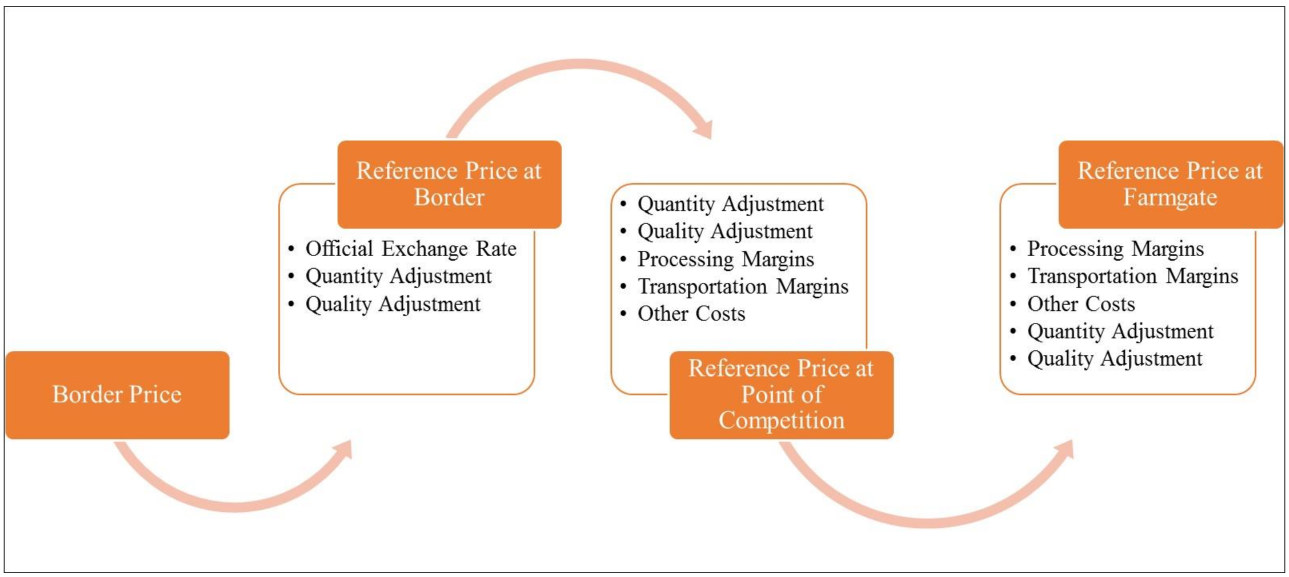

Figure 1 Price transmission across different locations of measurement

Figure **1** presents the methodology used in our analysis for the NRP of the complete value chain. Please note the three different locations of measurement used in our analysis. First one is the border where international price is used. In order to isolate the effects of price policies and markets, prices being compared must be for the same commodity in terms of quality and quantity. We must compare “like with like”. We pick an $Price^{Int}$ for which Type and Quality should be close to what farmers produce. The second location is Point of Competition, which we use to mark the main market for trade of goods within the country. This can be wholesale market or retail market, depending on the marketing costs used. The

[1] For a detailed discussion and examples of components of marketing costs, please refer to MAFAP (2016).

third one is at farmgate, where we use harvest prices earned by farmers. As noted above, when price transmission between each point in the market is evaluated, we use three categories of adjustment factors that reflect the proper value chain. These are quantity adjustment, quality adjustment, and marketing costs (here given in detail as processing margins, transportation margins, and other costs).

4.4 Computation of Reference Price at Farmgate

We use $Price^{Int}$ to note international price at the border of the country that we choose to use as our ***undistorted*** benchmark price. $Price_{Border}^{Reference}$ is reference price at the border,$Price_{POC}^{Reference}$ is point of competition price, $Price_{Farmgate}^{Reference}$ is reference price at the farmgate, $Price^{Farmgate}$ is price received by farmers at harvest time, and NRP as nominal protection rate for farmers.

Eq 12 $Price_{Border}^{Reference} = Exchange\ Rate \cdot Price^{Int}$

The $Price_{Border}^{Reference}$, here proxied by international price, reflects the opportunity cost for domestic market participants and is free of domestic policy interventions or impacts of domestic market functioning. Thus, the net trade status of the commodity must be known to select the appropriate benchmark/international price. In our study, we use previous literature to formulate as follows. $Price^{Int}$ is FOB (free on board) price of a major exporter country if India is a net exporter of the commodity under analysis and $Price^{Int}$ is CIF (cost, insurance and freight) price for India if India is a net importer of the commodity under analysis.

In order to isolate the effects of price policies and markets, prices being compared must be for the same commodity in terms of quality and quantity. We must compare “like with like”. We pick a $Price^{Int}$ for which *type* and *quality* should be close to what farmers produce. If this is not possible, a quality factor adjustment needs to be included in the analysis. If prices being compared are for products that are different due to processing or other physical treatment, the reference price must reflect this difference and a quantity factor adjustment needs to be included.

When we move from $Price_{Border}^{Reference}$ to $Price_{POC}^{Reference}$, we again need to make two prices comparable by making quantity adjustments, quality adjustments, and marketing costs adjustments if necessary. In the case of an imported commodity, $Price_{Border}^{Reference}$ is made comparable to the observed domestic price at the point of competition by adding the marketing costs between the border and the point of competition. This takes into account all the costs incurred by importers to bring the commodity to market resulting in the $Price_{POC}^{Reference}$.

Eq 13

$$Price_{POC}^{Reference} = (Price_{Border}^{Reference} \cdot QuantityAdjustment - QualityAdjustment) + Marketing\ Costs$$

In the case of an exported commodity, $Price_{Border}^{Reference}$ is made comparable to the observed domestic price at the point of competition by subtracting the marketing costs between the border and the point of competition. This takes into account all the costs incurred by exporters in bringing the commodity from the point of competition to the border, resulting in the $Price_{POC}^{Reference}$.

Eq 14

$$Price_{POC}^{Reference} = (Price_{Border}^{Reference} \cdot QuantityAdjustment - QualityAdjustment) - Marketing\ Costs$$

The $Price_{POC}^{Reference}$ is made comparable to the observed domestic price at farmgate ($Price^{Farmgate}$) by subtracting the marketing costs between the farmgate and the point of competition. This takes into account all the costs incurred by farmers to bring the commodity from the farm to the point of competition, resulting in the $Price_{Farmgate}^{Reference}$.

Eq 15

$$Price_{Farmgate}^{Reference} = (Price_{POC}^{Reference} \cdot QuantityAdjustment - QualityAdjustment) - Marketing\ Costs$$

$Price^{Farmgate}$ is defined as price received by farmer from the purchaser for a unit of a good produced as output net of any Value Added Tax, invoiced to the purchaser. It also excludes any transport charges invoiced separately by the producer. In our analysis, this is harvest price *data* we collected.

Finally,

Eq 16 $$NRP = \frac{(Price^{Farmgate} - Price_{Farmgate}^{Reference})}{Price_{Farmgate}^{Reference}} - 1$$

4.5 How to integrate Value Chain in NRP computation?

This study aims to compute the NRP for a complete value chain, in the existence of by-products and upstream processed commodities. Our objective is to understand how farmers' protection change if there is a new market for their products and how it can be quantified by the NRP methodology. This new market can develop due to demand (in the case of meal and oil markets from oilseeds) or due to policy (in the case of ethanol that expanded with biofuel policy impetus in India). This complete value chain NRP shows the rate of sectoral protection along the complete value chain up to the farmgate.

To this end, we utilize the I-O coefficient data for primary and processed goods (and by-products) to generate NRPs for the complete value chain. Our aim is to compute a reference price for these processed goods (and by-products) that is comparable to $Price_{Farmgate}^{Reference}$ of the primary commodity. To this end, we use the compare "like with like" rule and apply it to each case in our study.

We first, look at two oilseeds complexes: rapeseed and groundnut. We need a methodology to compute how much NRP for the rapeseed and groundnut producer changes when there are markets for the processing of the primary commodity. In our case, we need to include additional NRP from rapeseed meal, rapeseed oil, groundnut oil, and groundnut meal markets. Appendix Figure 1 presents computation of $Price_{Farmgate}^{Reference}$ for groundnut, whereas Appendix Figure 2 and Appendix Figure 3 present computation of $Price_{Farmgate}^{Reference}$ for groundnut oil and groundnut meal. In both cases, $Price^{POC}$ is computed for the processed commodities of oil and meal using the same methodology discussed in section 4.4. In the final step, input-output coefficient between primary commodity and processed commodity is used to generate a $Price_{Farmgate}^{Reference}$ for these commodities that is comparable to the primary commodity price. Specifically, 1 metric ton of groundnut generates 0.33 metric ton of groundnut oil and 0.39 ton of groundnut meal.

Groundnut oil price of Rupees per metric ton is multiplied by 0.33 to convert this price into groundnut price equivalent. The same conversion is done for groundnut meal price as seen in Appendix Figure 3.

Similarly, Appendix Figure 4, Appendix Figure 5, and Appendix Figure 6 present price transmission of seed, oil, and meal along rapeseed complex value chain. The input-output coefficient for rapeseed oil from rapeseed is 0.38 and rapeseed meal from rapeseed is 0.60. These are utilized to compute $Price_{Farmgate}^{Reference}$ for rapeseed oil and rapeseed meal separately at rapeseed equivalent.

In ethanol value chain analysis, we need to consider both the sugar mills and the distilleries. In India, sugar (raw or gur) is produced from sugarcane. Molasses is a by-product of this processing at the mill and molasses has a market of its own in India for food and feed use. With biofuel policy impetus, there was an expanding market for ethanol due to mandates/targets to blend gasoline with ethanol. In India, distilleries make ethanol from molasses and generate a new market for molasses and indirectly for sugarcane.[2] Appendix Figure 11 presents the shift in demand for sugarcane due to biofuel policy shift.

In our analysis, we need to consider both the additional NRP coming from molasses market and the additional NRP coming from ethanol market separately. At the same time, we need to link the ethanol value chain to the molasses value chain as ethanol is a by-product of molasses and molasses is a by-product of sugarcane. Appendix Figure 7 and Appendix Figure 8 present the two interlinked value chains separately, to be clearer. In Appendix Figure 7, we first employ quantity conversion rate to convert ethanol price into its molasses equivalent, with 240 liter of ethanol being generated per metric ton of molasses. Next, we employ the conversion rate between molasses and sugarcane, 0.04 ton of molasses per ton of sugarcane, to compute the ethanol price at sugarcane equivalent. This is the $Price_{Farmgate}^{Reference}$ for ethanol at sugarcane equivalent. Appendix Figure 8 shows the price transmission for molasses along this value chain, where only the conversion rate between molasses and sugarcane, 0.04 ton of molasses per ton of sugarcane, is used to generate $Price_{Farmgate}^{Reference}$ for molasses at sugarcane equivalent.

Data for India at state level is available for some states at farmgate sugarcane level and for some states at farmgate raw sugar level. To be able to include a wide range of estimates, we included data for states at raw sugar level at the farmgate as well. We adjusted quantity conversions using the I-O coefficient of 0.102 metric ton of sugar from sugarcane.

4.6 NRPs for Value Chains

All domestic price data is at state level and thus we are able to compute NRPs at state level for to show the impact of both federal and state level policies on farmers.

As described in above section, we integrated NRPs for primary commodities and NRPs for processed commodities (by-products) to estimate an NRP for the whole value chain. Specifically, we started with NRPs for primary commodities following Krueger, Schiff, and Valdes (1988). We have four primary commodities, sugar, sugarcane, groundnut, and rapeseed.

Eq 17 $NRP_{Sugar} = \frac{Price_{Sugar}^{Farmgate}}{Price_{Sugar}^{Reference}} - 1$

Eq 17* $NRP_{Sugarcane} = \frac{Price_{Sugarcane}^{Farmgate}}{Price_{Sugarcane}^{Reference}} - 1$

[2] Please note that this is different from Brazil, where either ethanol or sugar is made from sugarcane.

Eq 18 $NRP_{Groundnut} = \frac{Price^{Farmgate}_{Groundnut}}{Price^{Reference}_{Groundnut}} - 1$

Eq 19 $NRP_{Rapeseed} = \frac{Price^{Farmgate}_{Rapeseed}}{Price^{Reference}_{Rapeseed}} - 1$

Let's start our analysis with ethanol-molasses-sugarcane value chain. The above NRPs in equation 17 and equation 17* show the protection farmers receive through domestic policies pertaining to sugarcane. When a by-product is generated with a markets of its own, farmers receive a higher price for the primary agricultural commodity they produce. At the same time, these by-products or processed commodities can be protected by domestic agricultural policies pertaining to their markets. Thus, we need to differentiate between additional NRP coming from a new market and the additional NRP coming from the protection of this new market. Thus, when we are computing NRP for the complete value chain, we need to have two separate $Price^{Reference}_{Farmgate}$, one based on $Price^{Int}$ and one based on domestic price of this by-product ($Price^{Domestic}$). For example, for ethanol, $Price^{Int}$ is Brazilian ethanol export price and $Price^{Domestic}$ is Indian ethanol price, fixed by legislation, that the refiners buy ethanol from the distilleries.

For the molasses by-product, the NRP for the molasses-sugar value chain is

Eq 20 $NRP^{International}_{Molasses} = \frac{Price^{Farmgate}_{Sugar} + share^{M} \cdot Price^{Molasses,international}_{Sugar\ equivalent}}{Price^{Reference}_{Sugar}} - 1$

The NRP for the molasses-sugarcane value chain is

Eq 20* $NRP^{International}_{Molasses} = \frac{Price^{Farmgate}_{Sugarcane} + share^{M} \cdot Price^{Molasses,international}_{Sugarcane\ equivalent}}{Price^{Reference}_{Sugarcane}} - 1$

These above NRPs reflect the additional NRPs sugarcane farmers receive when molasses market is protected by domestic policies.

NRP formula for molasses-sugar value chain when domestic molasses price is used and when protection of molasses market is not taken into account are

Eq 21 $NRP^{Domestic}_{Molasses} = \frac{Price^{Farmgate}_{Sugar} + share^{M} \cdot Price^{Molasses,Domestic}_{Sugar\ equivalent}}{Price^{Reference}_{Sugar}} - 1$

NRP formula for molasses-sugarcane value chain when domestic molasses price is used and when protection of molasses market is not taken into account are

Eq 21* $NRP^{Domestic}_{Molasses} = \frac{Price^{Farmgate}_{Sugarcane} + share^{M} \cdot Price^{Molasses,Domestic}_{Sugarcane\ equivalent}}{Price^{Reference}_{Sugarcane}} - 1$

Same logic follows for ethanol market. NRP formula for ethanol-molasses-sugar value chain when protection of Indian ethanol market is taken into account are

Eq 22 $$NRP_{Ethanol}^{International} = \frac{Price_{Sugar}^{Farmgate} + share^{M} \cdot Price_{Sugar\ equivalent}^{Molasses,International} + (share^{M}) \cdot (share^{E}) \cdot Price_{Sugar\ equivalent}^{Ethanol,International}}{Price_{Sugar}^{Reference}} - 1$$

NRP formula for ethanol-molasses-sugarcane value chain when protection of Indian ethanol market is taken into account are

Eq 22* $$NRP_{Ethanol}^{International} = \frac{Price_{Sugarcane}^{Farmgate} + share^{M} \cdot Price_{Sugarcane\ equivalent}^{Molasses,International} + (share^{M}) \cdot (share^{E}) \cdot Price_{Sugarcane\ equivalent}^{Ethanol,International}}{Price_{Sugarcane}^{Reference}} - 1$$

NRP formula for ethanol-molasses-sugar value chain when protection of Indian ethanol and molasses market is NOT taken into account are

Eq 23 $$NRP_{Ethanol}^{Domestic} = \frac{Price_{Sugar}^{Farmgate} + share^{M} \cdot Price_{Sugar\ equivalent}^{Molasses,Domestic} + (share^{M}) \cdot (share^{E}) \cdot Price_{Sugar\ equivalent}^{Ethanol,Domestic}}{Price_{Sugar}^{Reference}} - 1$$

NRP formula for ethanol-molasses-sugarcane value chain when protection of Indian ethanol and molasses market is NOT taken into account are

Eq 23* $$NRP_{Ethanol}^{Domestic} = \frac{Price_{Sugarcane}^{Farmgate} + share^{M} \cdot Price_{Sugarcane\ equivalent}^{Molasses,Domestic} + (share^{M}) \cdot (share^{E}) \cdot Price_{Sugarcane\ equivalent}^{Ethanol,Domestic}}{Price_{Sugarcane}^{Reference}} - 1$$

The difference in equation 22 and equation 23 above show us 'how much value chain NRP changes if we do not protect domestic ethanol and molasses industry'. In other words, it shows how much protection of ethanol and molasses sector trickles down to protection of sugarcane producers. This shows how protection passes through value chain and impact beginning of value chain, i.e. sugarcane producers. Note that $share^{M}$ is the share of sugarcane or raw sugar going into molasses production, which is 1 in our case since molasses is a by-product. $share^{E}$ is how much molasses is diverted into ethanol production rather than being consumed. This is based on data in our analysis.

We use the same logic for oilseeds complex, making necessary adjustments for the nature of the value chain. NRP formula for groundnut value chain at International Prices when we consider protection of groundnut meal and groundnut oil is

Eq 24 $$NRP_{Groundnut\ complex}^{International} = \frac{Price_{Groundnut}^{Farmgate} + Price_{Groundnut\ equivalent}^{Oil,International} + Price_{Groundnut\ equivalent}^{Meal,International}}{Price_{Groundnut}^{Reference}} - 1$$

NRP formula for groundnut value chain at Domestic Prices when we do not consider protection of groundnut meal and groundnut oil is

Eq 25 $$NRP_{Groundnut\ complex}^{Domestic} = \frac{Price_{Groundnut}^{Farmgate} + Price_{Groundnut\ equivalent}^{Oil,Domestic} + Price_{Groundnut\ equivalent}^{Meal,Domestic}}{Price_{Groundnut}^{Reference}} - 1$$

NRP formula for rapeseed value chain at International Prices when we consider protection of rapeseed meal or rapeseed oil is

Eq 26 $NRP^{International}_{Rapeseed\ complex} = \frac{Price^{Farmgate}_{Rapeseed} + Price^{Oil,International}_{Rapeseed\ equivalent} + Price^{Meal,International}_{Rapeseed\ equivalent}}{Price^{Reference}_{Rapeseed}} - 1$

NRP formula for rapeseed value chain at Domestic Prices when we do not consider protection of rapeseed meal or rapeseed oil is

Eq 27 $NRP^{Domestic}_{Rapeseed\ complex} = \frac{Price^{Farmgate}_{Rapeseed} + Price^{Oil,Domestic}_{Rapeseed\ equivalent} + Price^{Meal,Domestic}_{Rapeseed\ equivalent}}{Price^{Reference}_{Rapeseed}} - 1$

4.7 Value Chain Rate of Protection

We also wanted to look at the value (in million Rupees) of the value chain at the beginning of value chain (using reference prices) and at the end of the value chain (using domestic prices). This analysis was conducted at India level, not state level. We are computing Value of Production for complete value chain using domestic prices and using reference prices (based on international prices). We wanted to look at this ratio to understand how the value of production changes when a value chain is protected and when it is not protected. This gives us a different view on the impact of protection while taking into consideration production levels. We name this ratio as Value Chain Rate of Protection (VCRP).

For ethanol-molasses-sugar value chain, VCRP formula is

Eq 28 $VCRP = \frac{VP^{Farmgate\ price}_{Sugar} + VP^{Domestic\ price}_{molasses} + VP^{Domestic\ price}_{ethanol}}{VP^{Reference\ price}_{Sugar} + VP^{Reference\ price}_{molasses} + VP^{Reference\ price}_{ethanol}} - 1$

where $VP = Value\ of\ Production = Price\ \cdot Production\ Quantity$

For ethanol-molasses-sugarcane value chain, VCRP formula is

Eq 28* $VCRP = \frac{VP^{Farmgate\ price}_{Sugarcane} + VP^{Domestic\ price}_{Molasses} + VP^{Domestic\ price}_{Ethanol}}{VP^{Reference\ price}_{Sugarcane} + VP^{Reference\ price}_{Molasses} + VP^{Reference\ price}_{Ethanol}} - 1$

For groundnut value chain, VCRP formula is

Eq 29 $VCRP = \frac{VP^{Farmgate\ price}_{Groundnut} + VP^{Domestic\ price}_{Oil} + VP^{Domestic\ price}_{Meal}}{VP^{Reference\ price}_{Groundnut} + VP^{Reference\ price}_{Oil} + VP^{Reference\ price}_{Meal}} - 1$

For rapeseed value chain, VCRP formula is

Eq 30 $VCRP = \frac{VP^{Farmgate\ price}_{Rapeseed} + VP^{Domestic\ price}_{Oil} + VP^{Domestic\ price}_{Meal}}{VP^{Reference\ price}_{Rapeseed} + VP^{Reference\ price}_{Oil} + VP^{Reference\ price}_{Meal}} - 1$

5. Data collection and assumptions

Price data from various sources (international and India) is collected for the rapeseed complex (seed, meal, and oil), groundnut complex (seed, meal, and oil), and biofuels complex (ethanol, molasses, sugar, gur, and sugarcane). Price data is from different market locations such as border, retail, wholesale, and farmgate. This data is used to generate quality adjustments and marketing costs along the value chain.

All domestic price data is at state level and all international price data is one country chosen as the best representative price of that commodity. Analysis is done for 2008, 2009, 2010, and 2011 in marketing years where crop calendar from Agricultural Statistics of GOI is used to convert calendar year data to marketing year data. Detailed data documentation is given in Appendix 7.2 section.

The net trade status of the agricultural commodities used is computed using PS&D Online database published by USDA (2015a) (net trade = exports - imports). Exchange rate is Rupees per US$ and is from World Development Indicators (2015). State level production for the agricultural commodities, conversion rates between commodities, and input-output coefficients is from Agricultural Statistics published by GOI. These are also used to compute the quantity adjustments along the value chain.

Price data is from various sources. International prices are from various sources such as USDA ERS (USDA 2015b, USDA 2015c) and GAIN Reports (2015). Retail prices and farmgate (harvest) prices are from Agricultural Statistics published by GOI. Wholesale prices is from IndiaStat (2015).

For quality adjustments and for marketing costs, we are limited by data availability. Since we did not have sources to measure quality adjustments and for marketing costs between border and point of competition and between point of competition and farmgate separately, we applied this data only once between point of competition and farmgate. For quality adjustment, we had price data for sugar and gur at the retail market. Since these prices are at the same location of measurement, we used the difference between these prices to compute the quality adjustment for sugar between point of competition and farmgate. This was also applied to sugarcane with relevant conversion rates.

For marketing costs data, we had a wider range of sources. We had access to wholesale prices and retail prices for all the agricultural commodities used in this analysis at state level. Some state level data is missing, but we have data for most states and utilized these to compute marketing costs to be applied between point of competition and farmgate. Note that for us marketing cost data is a proxy for the sum of all margins from point of competition to farmgate: processing costs, transport costs, handling costs, taxes and fees, other costs.

All price data are converted from various units (e.g. per 15 kg, or per 100 kg) to per metric ton. All quantity data are converted from various units (e.g. kg, 100 kg, or million liters) to per metric ton or liters. International prices converted to Indian Rupees using WDI exchange rates.

International prices are as follows. Molasses is U.S. blackstrap molasses prices from USDA (2015c). Ethanol is Brazilian fuel hydrous ethanol price for the state of Sao Paulo from GAIN Reports (2015). Sugar is raw sugar price, ICE Contract 11 nearby futures price form USDA (2015c). Groundnut oil is US Peanut oil, crude, tank cars f.o.b. Southeastern mills from USDA (2015b). Groundnut is US, groundnut prices received by farmers, from USDA (2015b). Groundnut meal is peanut meal, 50 percent protein, f.o.b. Southeastern mills from US from USDA (2015b). Rapeseed is Hamburg CIF; Europe "00"; from Oil World (2015). Rapeseed meal is Hamburg FOB; Ex-Mill 34% Protein; from Oil World (2015). Rapeseed oil is Rotterdam, Dutch FOB Ex-Mill; from Oil World (2015).

6. Results

Tables 1 to 5 present results for India as averages of state level NRPs. We will first discuss these to give an overall sense protection in India. We will follow up with state level NRP discussion.

Results show that for the 2008/09 to 2011/12 period, on average, NRPs for the analyzed primary commodities (sugarcane, raw sugar, groundnut, and rapeseed) are positive for India. This is true for the majority of the states as well. This suggests that GOI and state governments have effectively protected the farmers producing these crops. When NRPs are computed for the value chain, results show that including by-products and processed commodities in the value chain while computing NRP increases the NRPs for the primary commodities significantly. This suggests that farmers on average benefited from creation or expansion of value chains for their produce.

Table 1 shows the NRPs for ethanol-molasses-sugar and for ethanol-molasses-sugarcane value chains using international prices. These NRPs take into consideration the protection afforded to by-products (molasses and ethanol) by using international prices for ethanol and molasses. Please note that farmgate price is still domestic for sugarcane and sugar. NRP for primary commodity is 310% for sugar and 473% for sugarcane. When molasses is included in the value chain, NRP for sugar producers increase to 360%. When ethanol is included to this value chain, NRP increases to 388%. When we look at NRPs with sugarcane prices, adding molasses increases NRP to 513% and adding ethanol increases NRP to 537%. We can observe that although sugarcane producers are protected heavily by federal and state policies, addition of these by-products along the value chain increases their income and NRPs. Please note that this result also reflects 100% pass-through assumption we used. If data is available and if we can apply only the additional profit farmers see from molasses and ethanol, this increase in NRP would still be positive, but reduced.

Table 2 shows how value chain NRPs would look like if ethanol and molasses markets are not protected and the additional NRP to sugarcane farmers come from existence of molasses and ethanol value chains only. To this end, we use domestic prices for ethanol and molasses. In this case, addition of molasses increases NRP to 346% from 310% for sugar. Addition of ethanol to this value chain increases NRP to 373%. If we compare these NRPs to above NRPs with international prices, we see that protection of molasses increases NRP for value chain 14% points (360% - 346%). Next, protection of ethanol industry in India increases NRP for value chain by 11% points (388% - 373%). When we look at this value chain with sugarcane prices, addition of molasses increases NRP for sugarcane to 502% from 473%. Adding ethanol, increases sugarcane NRP to 525%. With this set of results, we see an additional NRP of 11% points (513% - 502%) with protection of molasses. The protection of ethanol adds 12% points (537% - 525%) of protection to sugarcane producers. On average for India, groundnut seed NRP is 11% (Table 3). Adding groundnut oil and groundnut meal value chain increases this NRP to 110% for India on average when international prices are used for groundnut oil and groundnut meal. When we use domestic prices for these by-products, NRP for groundnut complex value chain is 129% (Table 4). Thus, protection of groundnut oil and groundnut meal increases NRP by 19% points (129% - 110%).

On average for India, rapeseed NRP is 20% when international prices are used[3]. Adding rapeseed oil and rapeseed meal value chain in NRP computation increases this to 122% when international prices are used for rapeseed oil and rapeseed meal. When we use domestic prices for these by-products, NRP for rapeseed complex value chain is 128% (Table 4). Thus, protection of rapeseed oil and rapeseed meal increases NRP by 6% points (128% - 122%).

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[3] Due to different data availability for states, rapeseed NRP for with domestic prices and international prices use different states. Thus, there is a gap between rapeseed NRP in Table 3 and Table 4.

Comparison of Table 1 and Table 2, Table 3 and Table 4 summarized above, shows that farmers can be protected not only through creation and expansion of value chains (markets) for their products, but also through the protection of these upstream value chains. In our study, Indian farmers are protected directly for their primary commodities. However, they are protected in two additional ways: firstly through new value chains and secondly through protection of these value chains.

Let's look at NRP computations at state level, summarized in Appendix Table 1, Appendix Table 2, Appendix Table 3, and Appendix Table 4. These results give us a more direct analysis of the impact of state level policies on farmers. Furthermore, they show the wide range of NRPs among states. Overall, we see that states differ widely in their policies.

At state level, the range of NRP for raw sugar is between 53% (Chhattisgarh) to 588% (Rajasthan) from Appendix Table 1. When international prices are used, the NRP for molasses value chain range is 68% (Chhattisgarh) and 667% (Rajasthan). Adding ethanol creates a range of 78% (Chhattisgarh) and 704% (Rajasthan). The NRP for sugarcane is ranging between -30% (Kerala) and 2335% for Jammu & Kashmir. Using international prices, molasses value chain NRP range is -19% (Kerala) and 2385% (Jammu & Kashmir). Adding ethanol to this value chain NRP creates a range of -10% (Kerala) and 2413% (Jammu & Kashmir).

Appendix Table 2 gives the range of NRPs for states using domestic prices. At state level, the range of NRP for raw sugar is between 53% (Chhattisgarh) to 588% (Rajasthan). When domestic prices are used, the NRP for molasses value chain range is 64% (Chhattisgarh) and 644% (Rajasthan). Adding ethanol creates a range of 72% (Chhattisgarh) and 682% (Rajasthan). The NRP for sugarcane is ranging between -30% (Kerala) and 2335% for Jammu & Kashmir. Using domestic prices, molasses value chain NRP range is -23% (Kerala) and 2374% (Jammu & Kashmir). Adding ethanol to this value chain NRP creates a range of -16% (Kerala) and 2404% (Jammu & Kashmir).

The range of NRP for groundnut seed at state level is between -26% (Jharkand) and 86% (Himachal Pradesh). The NRP for groundnut value chain ranges between 65% (Jharkand) and 203% (Himachal Pradesh) when international prices are used as seen in Appendix Table 3. Appendix Table 4 provides same NRPs but using domestic prices for groundnut meal and groundnut oil. The state coverage is lower due to lack of data at state level for by-products. However, we can still see some trends. The range of NRP for groundnut at state level is between 0% (Andra Pradesh) and 21% (Tamil Nadu). The NRP for the groundnut value chain ranges between 110% (Andra Pradesh) and 144% (Gujarat).

The range of NRP for rapeseed is between -34% (Mizoram) and 97% (Tripura). The NRP for the complete rapeseed value chain ranges between 76% (Mizoram) and 206% (Tripura) when international prices are used for by-products as seen in Appendix Table 3. Appendix Table 4 provides same numbers using domestic prices for meal and oil. The state coverage is lower due to lack of data. However, we can still see some trends. The range of NRP for rapeseed at state level is between 4% (Delhi) and 14% (West Bengal). The NRP for rapeseed value chain ranges between 131% (Delhi) and 147% (West Bengal).

Table 5 looks at our question from a very different methodology and provides some useful insights as well. VCRP for the ethanol-molasses-sugar value chain is 144%. VCRP for the ethanol-molasses-sugarcane value chain is 71%. VCRP for the groundnut complex value chain is 33%. VCRP for the groundnut complex value chain is 15%. Although these are a range of estimates, overall, the value of production at the beginning of the value chain and at the end of the value chain differ. We wanted to look at this VCRP to understand how the value of production changes when a value chain is protected and when it is not protected.

7. Conclusions

The results show that GOI has effectively protected the farmers for the primary commodities included in this analysis, specifically sugarcane, raw sugar, groundnut, rapeseed. When a primary commodity is part of a value chain that generates additional products through processing, the effective NRPs for the farmers producing the primary commodity increase. This is due to the fact that farmers receive higher prices for their crop since there is additional value being generated through a larger market.

In our analysis, we are not only interested in NRP for inputs and NRP for outputs, but also how NRPs that a farmer faces change with the existence or creation of a value chain. We want to incorporate the place of each commodity within the value chain complex and with respect to each other. This is crucial in our analysis since we compute NRPs of both primary and processed commodities and integrate them for the NRP of the complete value chain.

Our results also show that farmers can be protected not only through creation and expansion of value chains (and thus new markets) for their products, but also through the protection of these upstream value chains. In our study, Indian farmers are protected directly for their primary commodities with positive NRPs overall. However, they are protected in two additional ways: firstly through new value chains and secondly through protection of these value chains. This second effect is shown by comparing NRPs of value chains when domestic prices and when international prices are used for by-products or processed commodities.

Measuring distortions along the entire value chain are therefore necessary for effective policy design and evaluation. One, excluding them may overestimate or underestimate the full impact of the entire policy space on the farmers. Two, in an environment of growing demand and limited natural resources, the importance of correct policy measurement, categorization, and interpretation for the optimal design, monitoring and evaluation of agricultural, environmental, and trade policies cannot be stressed enough. In this context, it is also crucial to identify which parts of agricultural distortions are due to market failure and distinguish these from the part that is due to effective policy intervention. Agricultural distortions, originating from either policy design or other sources, also create and influence value chains within a country or across countries. With the observed expansion of regional and global value chains, the measurement of distortions along the agricultural value chain is necessary for effective trade policy negotiations as well.

8. References

Agricultural Statistics. 2015. Directorate of Economics and Statistics, Department of Agriculture, Government of India, New Delhi. Accessed May 18, 2015. < http://eands.dacnet.nic.in/latest_2006.htm>

Anderson K., Kurzweil M., Martin W., Sandri D., Valenzuela E. (2008) Methodology for Measuring Distortions to Agricultural Incentives, Agricultural Distortions Working Paper 02, Development Research Group, World Bank, Washington DC.

GAIN (Global Agricultural Information Network). 2015. "GAIN Reports." Accessed May 18, 2015. <gain.fas.usda.gov/Pages/Default.aspx.>

IDB-Agrimonitor (2016) PSE Agricultural Policy Monitoring System, <http://www.iadb.org/en/topics/agriculture/agrimonitor/agrimonitor-pse-agricultural-policy-monitoring-system,8025.html>, Inter-American Development Bank, Washington, DC.

IndiaStat. 2015. "Various Tables". Accessed May 18, 2015. <http://www.indiastat.com>

Krueger A. O., Schiff M., Valdes A. (1988) Agricultural Incentives in Developing Countries: Measuring the Effect of Sectoral and Economywide Policies, *The World Bank Economic Review,* 2 (3), 255-271.

MAFAP (2016) Monitoring and Analysing Food and Agricultural Policies, < http://www.fao.org/in-action/mafap/home/en/> FAO, Rome.

OECD (2013) "Interconnected Economies: Benefiting from Global Value Chains". Synthesis Report. Available Online <http://www.oecd.org/sti/ind/interconnected-economies-GVCs-synthesis.pdf>

OECD (2015) Agricultural Policy Monitoring and Evaluation 2015, OECD Publishing, Paris http://dx.doi.org/10.1787/agr_pol-2015-en

Oil World. 2015. Accessed May 18, 2015. < http://www.oilworld.biz/app.php>

Pursell, G., A. Gulati, K. Gupta (2007) Distortions to Agricultural Incentives in India <http://siteresources.worldbank.org/INTTRADERESEARCH/Resources/544824-1163022714097/India_0608.pdf>

Schiff, M. and A. Valdes (1992) The Effects of Intervention on Agricultural Prices <http://siteresources.worldbank.org/INTTRADERESEARCH/Resources/544824-1146153362267/ThePoliticalEconomyofAg_Pricing_Policy_vol4_AsynthesisofDevelopingCountries.pdf >

USDA. 2015a. *Production, Supply, and Distribution.* Accessed May 18, 2015. <www.fas.usda.gov/psdonline/psdHome.aspx>

USDA. 2015b. Economic Research Service Oil Crops Yearbook. Accessed May 18, 2015. <http://www.ers.usda.gov/data-products/oil-crops-yearbook.aspx>

USDA 2015c. Economic Research Service Sugar and Sweeteners Yearbook Tables. Accessed May 18, 2015. <http://www.ers.usda.gov/data-products/sugar-and-sweeteners-yearbook-tables.aspx>

Valdes, A. and W. Foster. (2011) "A profile of border protection in Egypt: an effective rate of protection approach adjusting for energy subsidies" Policy Research Working Paper 5685 The World Bank Middle East and North Africa Region Poverty Reduction and Economic Management Unit <http://www-wds.worldbank.org/external/default/WDSContentServer/WDSP/IB/2011/06/16/000158349_20110616083750/Rendered/PDF/WPS5685.pdf>

World Bank. 2015. World Development Indicators. Accessed May 7, 2015. <http://data.worldbank.org/indicator>

Table 1 India NRPs using international prices for Ethanol-Molasses-Sugar Value Chain

	International Prices		
	EQ 17 and EQ 17*	**EQ 20 and EQ 20***	**EQ 22 and EQ 22***
	Primary Commodity NRP	**Molasses Value Chain NRP**	**Ethanol + Molasses Value Chain NRP**
Primary Commodity	(%)	(%)	(%)
Raw Sugar	310%	360%	388%
Sugarcane	473%	513%	537%

Source: Authors' computations

Table 2 India NRPs using domestic prices for Ethanol-Molasses-Sugar Value Chain

	Domestic Prices		
	EQ 17 and EQ 17*	**EQ 21 and EQ 21***	**EQ 23 and EQ 23***
	Primary Commodity NRP	**Molasses Value Chain NRP**	**Ethanol + Molasses Value Chain NRP**
Primary Commodity	(%)	(%)	(%)
Raw Sugar	310%	346%	373%
Sugarcane	473%	502%	525%

Source: Authors' computations

Table 3 India NRPs using international prices for Oilseeds Value Chain

	International Prices	
	EQ 18 and EQ 19	**EQ 24 and EQ 26**
	Primary Commodity NRP	**Oilseeds Value Chain NRP**
Primary Commodity	(%)	(%)
Groundnut	11%	110%
Rapeseed	20%	122%

Source: Authors' computations

Table 4 India NRPs using domestic prices for Oilseeds Value Chain

	Domestic Prices	
	EQ 18 and EQ 19	**EQ 25 and EQ 27**
	Primary Commodity NRP	**Oilseeds Value Chain NRP**
Primary Commodity	(%)	(%)
Groundnut	11%	129%
Rapeseed	7%	128%

Source: Authors' computations

Table 5 India Value Chain Rate of Protection

Ethanol Complex with Raw Sugar	Ethanol Complex with Sugarcane	Groundnut Complex	Rapeseed Complex
EQ 28	**EQ 28***	**EQ 29**	**EQ 30**
(%)	(%)	(%)	(%)
144%	71%	33%	15%

Source: Authors' computations

7. Appendix

7.1 State level NRPs

Appendix Table 1 State Level NRPs using international prices for Ethanol-Molasses-Sugar Value Chain

		International Prices		
		EQ 17 and EQ 17*	**EQ 20 and EQ 20***	**EQ 22 and EQ 22***
		Primary Commodity NRP	**Molasses Value Chain NRP**	**Ethanol + Molasses Value Chain NRP**
Primary Commodity	**States**	**(%)**	**(%)**	**(%)**
Raw Sugar	Andhra Pradesh	217%	252%	280%
Raw Sugar	Assam	238%	268%	285%
Raw Sugar	Bihar	264%	312%	346%
Raw Sugar	Chhattisgarh	53%	68%	78%
Raw Sugar	Gujarat	105%	141%	156%
Raw Sugar	Haryana	407%	473%	515%
Raw Sugar	Kerala	159%	206%	222%
Raw Sugar	Madhya Pradesh	402%	467%	498%
Raw Sugar	Punjab	472%	534%	559%
Raw Sugar	Rajasthan	588%	667%	704%
Raw Sugar	Tamil Nadu	185%	214%	235%
Raw Sugar	Uttar Pradesh	383%	453%	497%
Raw Sugar	West Bengal	560%	626%	665%
Sugarcane	Assam	909%	953%	971%

Sugarcane	Goa	9%	35%	50%
Sugarcane	Gujarat	2%	16%	29%
Sugarcane	Jammu & Kashmir	2335%	2385%	2413%
Sugarcane	Karnataka	5%	26%	41%
Sugarcane	Kerala	-30%	-19%	-10%
Sugarcane	Maharashtra	102%	143%	166%
Sugarcane	Manipur	472%	513%	541%
Sugarcane	Mizoram	1290%	1362%	1394%
Sugarcane	Orissa	266%	368%	417%
Sugarcane	Punjab	69%	90%	109%
Sugarcane	Tripura	292%	309%	325%
Sugarcane	Uttar Pradesh	422%	492%	536%

Source: Authors’ computations

Appendix Table 2 State level NRPs using domestic prices for Ethanol-Molasses-Sugar Value Chain

		Domestic Prices		
		EQ 17 and EQ 17*	EQ 21 and EQ 21*	EQ 23 and EQ 23*
		Primary Commodity NRP	Molasses Value Chain NRP	Ethanol + Molasses Value Chain NRP
Primary Commodity	**States**	(%)	(%)	(%)
Raw Sugar	Andhra Pradesh	217%	241%	264%
Raw Sugar	Assam	238%	260%	275%
Raw Sugar	Bihar	264%	299%	329%
Raw Sugar	Chhattisgarh	53%	64%	72%
Raw Sugar	Gujarat	105%	131%	148%
Raw Sugar	Haryana	407%	457%	497%
Raw Sugar	Kerala	159%	192%	210%
Raw Sugar	Madhya Pradesh	402%	448%	479%
Raw Sugar	Punjab	472%	517%	544%
Raw Sugar	Rajasthan	588%	644%	682%
Raw Sugar	Tamil Nadu	185%	206%	224%
Raw Sugar	Uttar Pradesh	383%	436%	478%
Raw Sugar	West Bengal	560%	608%	644%
Sugarcane	Assam	909%	941%	961%
Sugarcane	Goa	9%	27%	41%
Sugarcane	Gujarat	2%	12%	21%

Sugarcane	Jammu & Kashmir	2335%	2374%	2404%
Sugarcane	Karnataka	5%	20%	33%
Sugarcane	Kerala	-30%	-23%	-16%
Sugarcane	Maharashtra	102%	132%	153%
Sugarcane	Manipur	472%	503%	528%
Sugarcane	Mizoram	1290%	1342%	1375%
Sugarcane	Orissa	266%	339%	388%
Sugarcane	Punjab	69%	83%	98%
Sugarcane	Tripura	292%	304%	315%
Sugarcane	Uttar Pradesh	422%	475%	518%

Source: Authors' computations

Appendix Table 3 State Level NRPs using international prices for Oilseeds Value Chain

		International Prices	
		EQ 18 and EQ 19	EQ 24 and EQ 26
		Primary Commodity NRP	Oilseeds Value Chain NRP
Primary Commodity	**States**	(%)	(%)
Groundnut	Andhra Pradesh	0%	94%
Groundnut	Bihar	30%	153%
Groundnut	Chhattisgarh	20%	136%
Groundnut	Gujarat	13%	120%
Groundnut	Haryana	36%	153%
Groundnut	Himachal Pradesh	86%	203%
Groundnut	Jammu & Kashmir	61%	178%
Groundnut	Jharkhand	-26%	65%
Groundnut	Karnataka	3%	120%
Groundnut	Madhya Pradesh	2%	119%
Groundnut	Maharashtra	-17%	100%
Groundnut	Orissa	-8%	109%
Groundnut	Punjab	15%	132%
Groundnut	Rajasthan	6%	123%
Groundnut	Tamil Nadu	21%	117%
Groundnut	Tripura	10%	101%
Groundnut	Uttar Pradesh	14%	131%

Groundnut	Puducherry	21%	138%
Rapeseed	Assam	4%	115%
Rapeseed	Bihar	9%	54%
Rapeseed	Chhattisgarh	30%	140%
Rapeseed	Gujarat	-1%	109%
Rapeseed	Haryana	6%	116%
Rapeseed	Himachal Pradesh	86%	197%
Rapeseed	Jammu & Kashmir	50%	160%
Rapeseed	Jharkhand	42%	154%
Rapeseed	Madhya Pradesh	4%	114%
Rapeseed	Manipur	-12%	98%
Rapeseed	Mizoram	-34%	76%
Rapeseed	Orissa	31%	141%
Rapeseed	Punjab	12%	123%
Rapeseed	Rajasthan	11%	121%
Rapeseed	Tripura	97%	206%
Rapeseed	Uttar Pradesh	4%	78%
Rapeseed	West Bengal	14%	102%
Rapeseed	Delhi	4%	93%

Source: Authors' computations

Appendix Table 4 State Level NRPs using domestic prices for Oilseeds Value Chain

		Domestic Prices	
		EQ 18 and EQ 19	**EQ 25 and EQ 27**
		Primary Commodity NRP	**Oilseeds Value Chain NRP**
Primary Commodity	**States**		
Groundnut	Andhra Pradesh	0%	110%
Groundnut	Gujarat	13%	144%
Groundnut	Tamil Nadu	21%	134%
Rapeseed	Uttar Pradesh	4%	107%
Rapeseed	West Bengal	14%	147%
Rapeseed	Delhi	4%	131%

Source: Authors' computations

7.2 Data documentation and data sources

Price Data

<u>Farmgate Prices</u>
Statewise Annual (Marketing Year) Farmgate prices were taken for 2004/05 to 2011/12 years for Sugarcane, Sugar Raw, Rapeseed&Mustardseed, and Groundnut from the Directorate of Economics and Statistics at the Department of Agriculture and Cooperation. For Sugarcane, and Sugar Raw, along with overall retail prices, Kharif and Rabi prices were also available. For Rapeseed&Mustardseed along with overall retail prices, Rabi Prices were also available. For Groundnut, along with overall retail prices, Kharif, Rabi, and Summer prices were also available. In cases where extra prices were available for states, the authors used the dominant season for that state.

<u>Wholesale Prices</u>
Statewise Monthly Wholesale prices were taken for January 2008 to December 2012 for Sugar, Groundnut and Rapeseed&Mustardseed and their respective oils and cakes from Ministry of Agriculture, Government of India through IndiaStat. These prices were then converted to marketing years. Each State reported multiple centers.
Molasses Prices were computed from molasses wholesale price index with monthly data (Ministry of Commerce and Industry, Government of India) and point Molasses wholesale prices from FAS GAIN reports. Monthly prices were then converted into marketing years using Sugar marketing year definition.

<u>Retail Prices</u>
Statewise Annual (Marketing Year) Retail prices were taken for MY 2005/06 to MY 2013/2014 for Sugar, Gur, Groundnut Oil, Mustard Oil from the Directorate of Economics and Statistics at the Department of Agriculture and Cooperation. Each state reported prices for multiple market centers and a representative center was chosen for each state.
Monthly Ethanol prices were gathered from FAS GAIN Reports for November 2008 to December 2014. These prices were converted into marketing year using Sugar marketing year definition. Ethanol prices are determined by the government and are therefore the Uniform Purchase Price and Procurement Price. The price is adjusted every few years by the government.

<u>International Prices</u>
Monthly International prices for 2008 to 2012 are converted to marketing year data from various sources such as USDA ERS (USDA 2015b, USDA 2015c) and GAIN Reports (2015) and selected as deemed relevant for the following commodities. International prices converted to Indian Rupees using WDI exchange rates from World Bank.

Sugar raw (ICE Contract 11 nearby futures price, from USDA (2015c))

Rapeseed (Hamburg CIF; Europe "00"; Oil World.)

Rapeseed Cake (Hamburg FOB; Ex-Mill 34% Protein; Oil World)

Rapeseed Oil (Rotterdam, Dutch FOB Ex-Mill; Oilworld)

Groundnut Oil (US Peanut oil, crude, tank cars f.o.b. Southeastern mills from USDA (2015b))

Groundnut (US, groundnut prices received by farmers, from USDA (2015b))

Groundnut meal (US, peanut meal, 50 percent protein, f.o.b. Southeastern mills from US from USDA (2015b))

Ethanol (Fuel Anhydrous Ethanol Prices: State of Sao Paulo (R$/000 liters), GAIN Reports (2015))

Molasses (U.S. blackstrap molasses prices, Houston, from USDA (2015c))

Production Data

<u>GOI: Ag Stats Data</u>
GOI data for State level data for 2011-12 and 2012/13 for production for the following crops were downloaded. Data is in marketing years.

<u>Major Crops</u>

- Groundnut (in-shell equivalent) (Nuts in Shell)
- Rapeseed & Mustardseed
- Sugarcane

State level data also included percentage of national level per state.

- Production (Million tons)

<u>Oilseed Production</u>
Primary Source of Oils

- Groundnut
- Rapeseed & Mustardseed

Production of oilseed data included

- Oilseed Production (Lakh tons)
- Oil Production (Lakh tons)

Other Data

<u>Conversion Factors</u>
For oilseed crops as well as primary and secondary agricultural commodities conversion factors were taken from the Government of India Ag Statistics handbook.

<u>Trade Status</u>
The net trade status of the agricultural commodities used is computed using PS&D Online database published by USDA (2015a). Here net trade is determined by the difference in exports and imports deeming a product as exported, imported, or not traded.

Data Notes

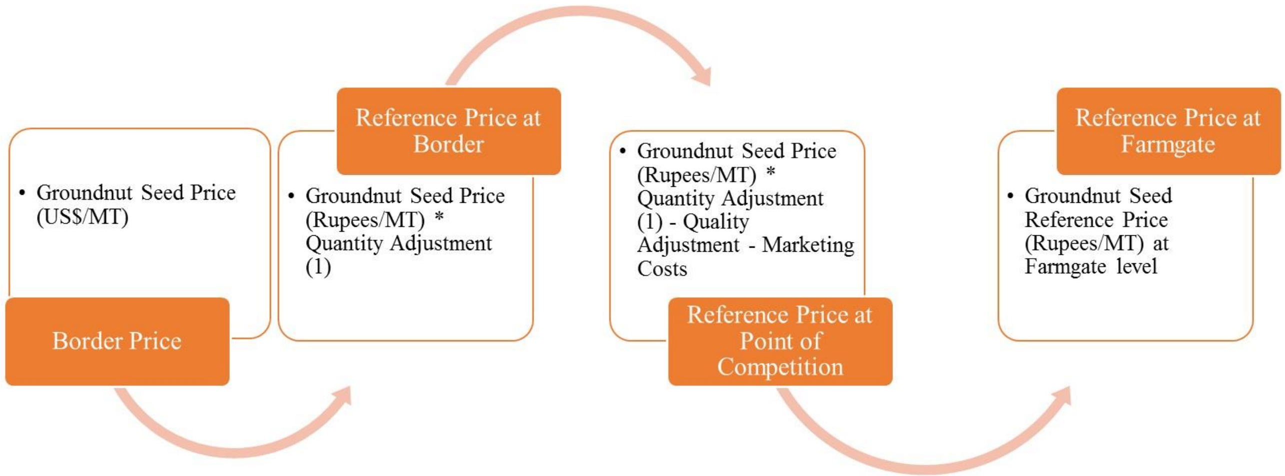
<u>Type of Groundnut</u>
Groundnut while unspecified at various locations has been assumed to be “nuts in shell” as groundnuts referred to in other GOI data are “groundnut (nuts in shell)” as mentioned in INPUT SURVEY 2011-12 Manual of Schedules and Instructions for Data Collection – Ministry of Agriculture Department of Agriculture & Cooperation.

<u>Centrifugal Sugar</u>

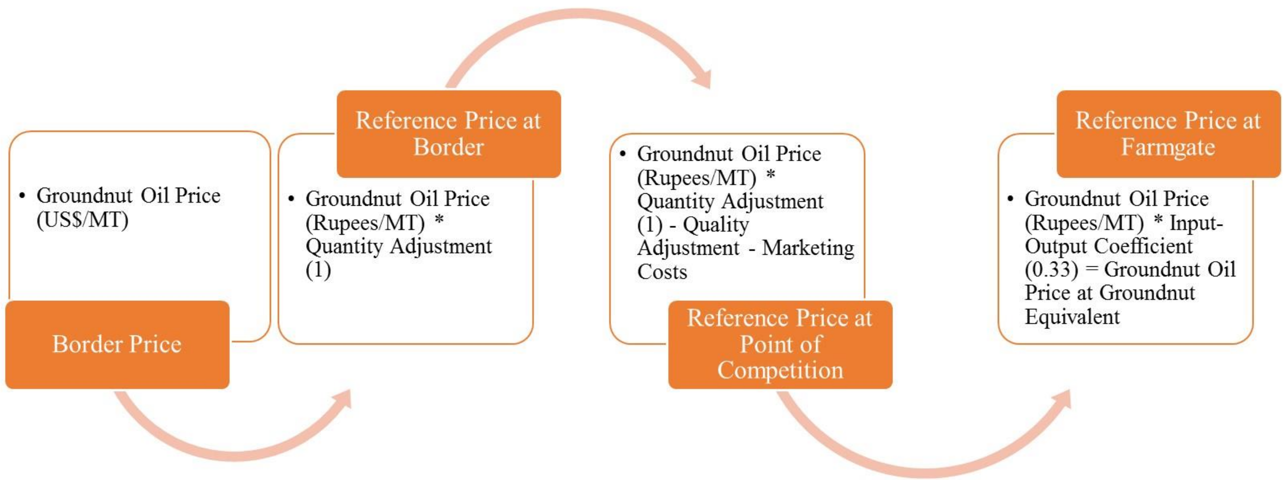
Centrifugal sugar is refined sugar. Raw sugar generally goes through the process of centrifuging twice, once at the start of the process to wash away the outer coating of the raw sugar crystals, and one towards the end of the refining process separate the sugar crystals from the supersaturated sugar solution (mother liquor) before drying to crystals.

7.3 Price Transmission along Value Chain

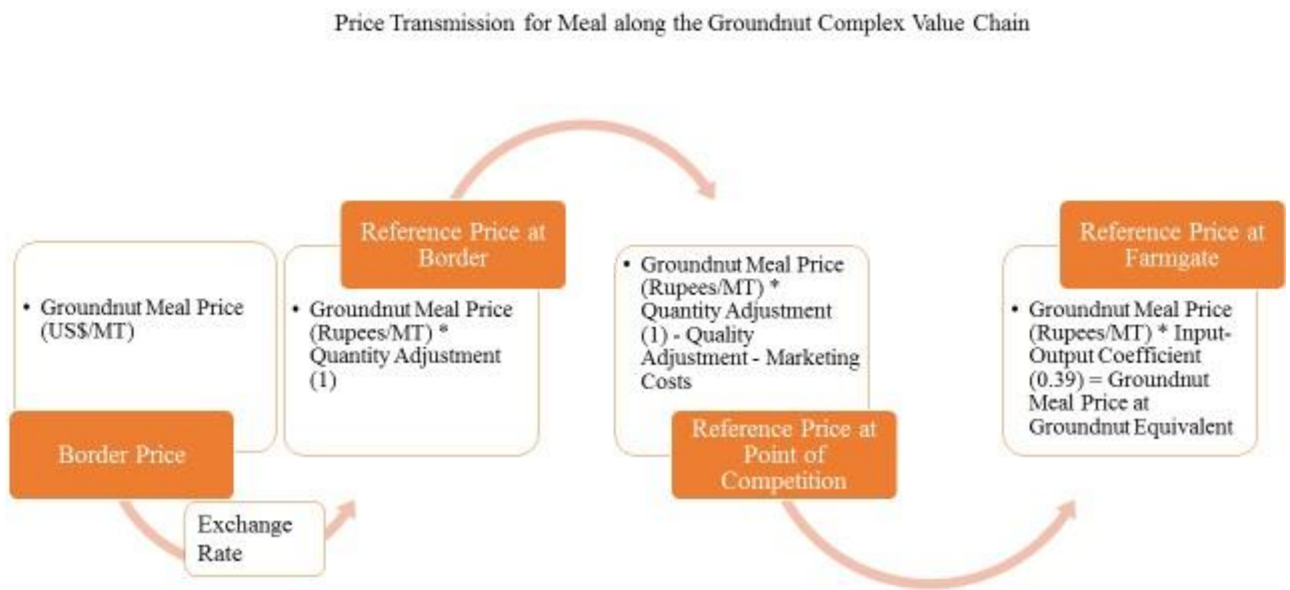
Appendix Figure 1 Price Transmission for Seed along the Groundnut Complex Value Chain



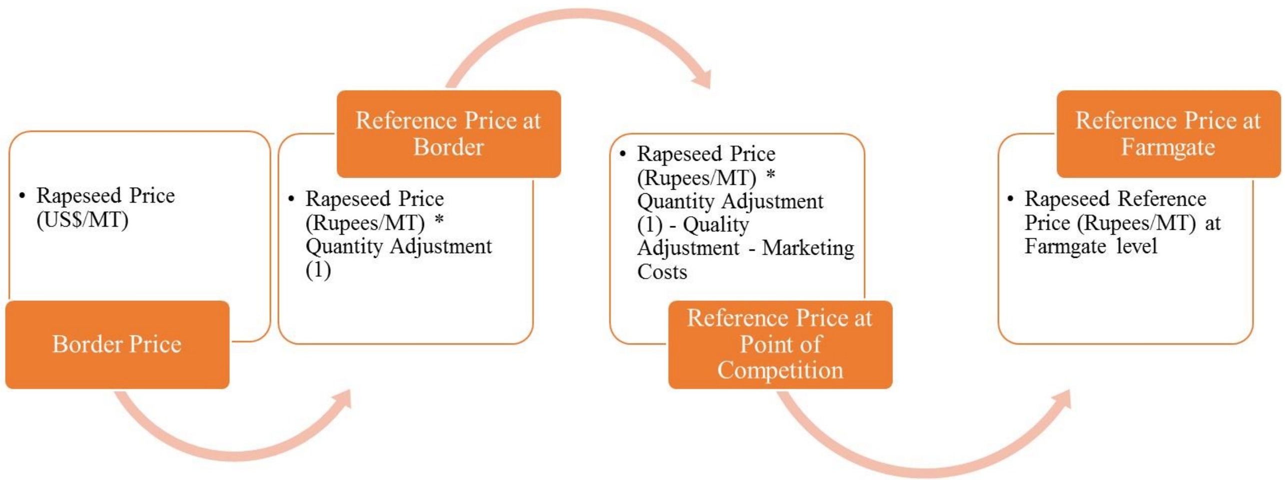
Appendix Figure 2 Price Transmission for Oil along the Groundnut Complex Value Chain



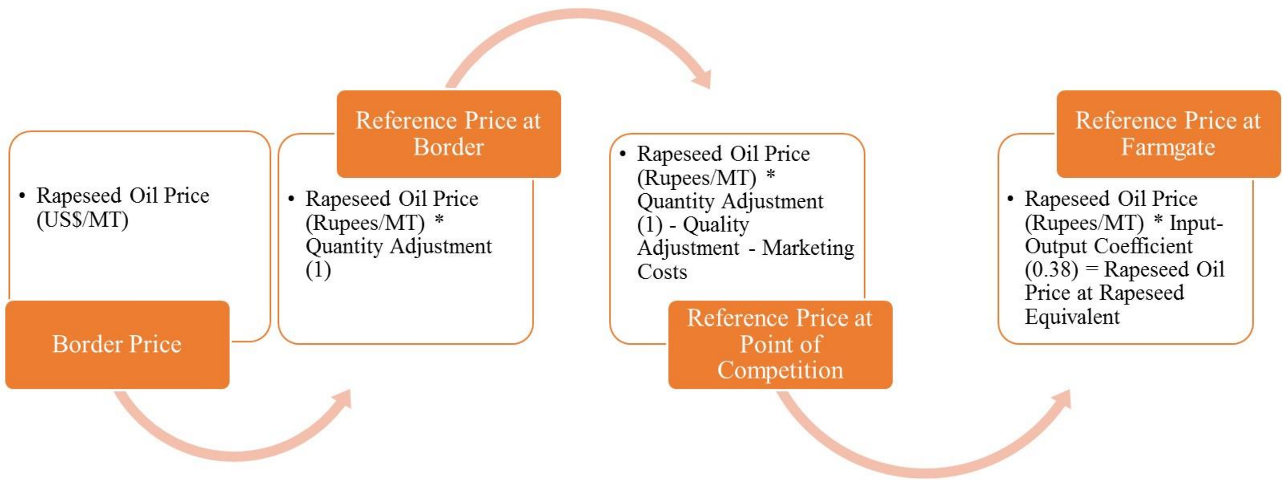
Appendix Figure 3 Price Transmission for Meal along the Groundnut Complex Value Chain



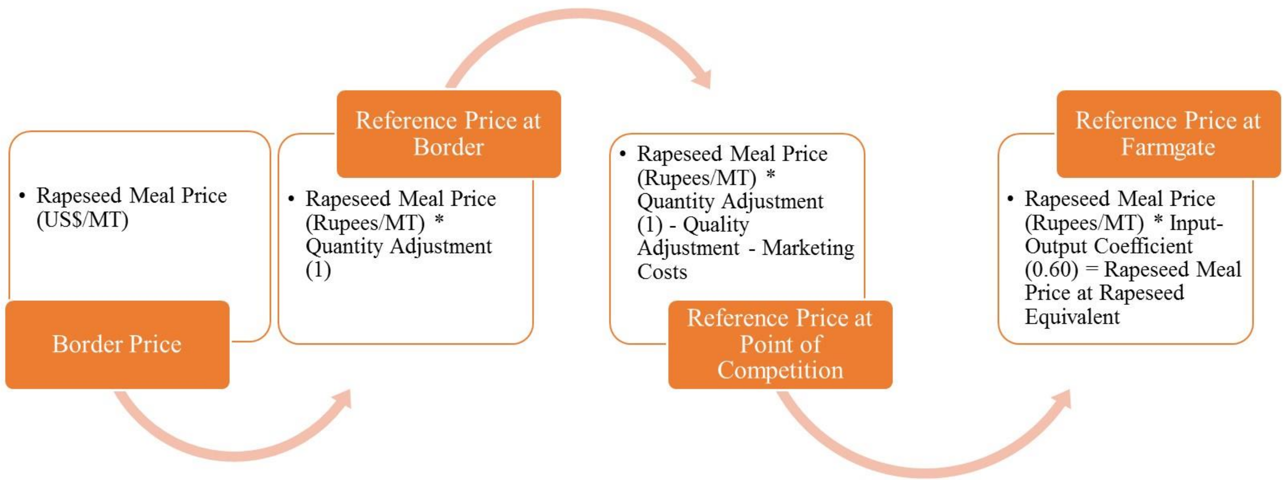
Appendix Figure 4 Price Transmission for Seed along the Rapeseed Complex Value Chain



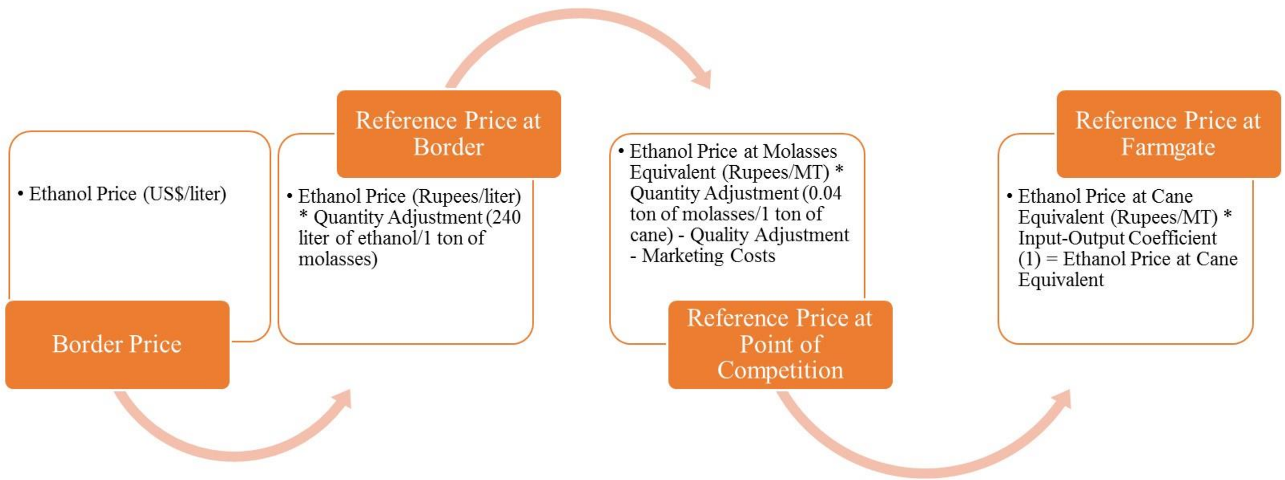
Appendix Figure 5 Price Transmission for Oil along the Rapeseed Complex Value Chain



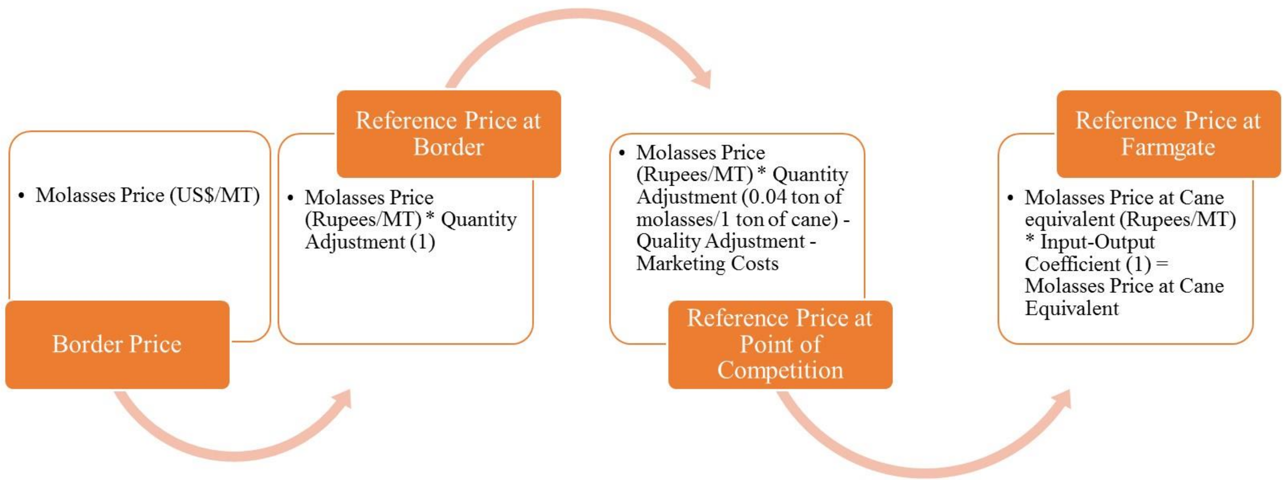
Appendix Figure 6 Price Transmission for Meal along the Rapeseed Complex Value Chain



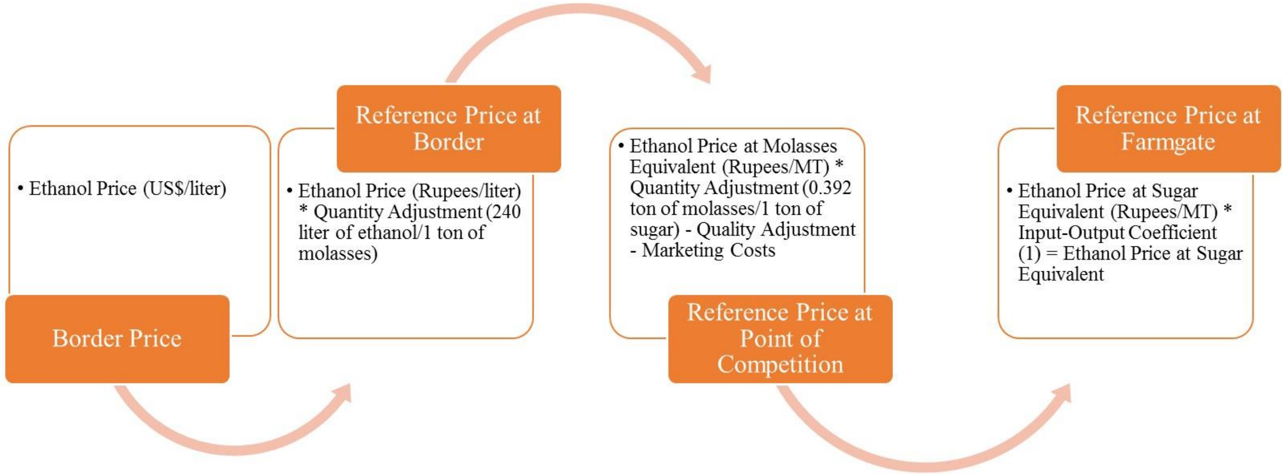
Appendix Figure 7 Price Transmission for Ethanol along the Ethanol-Molasses Value Chain



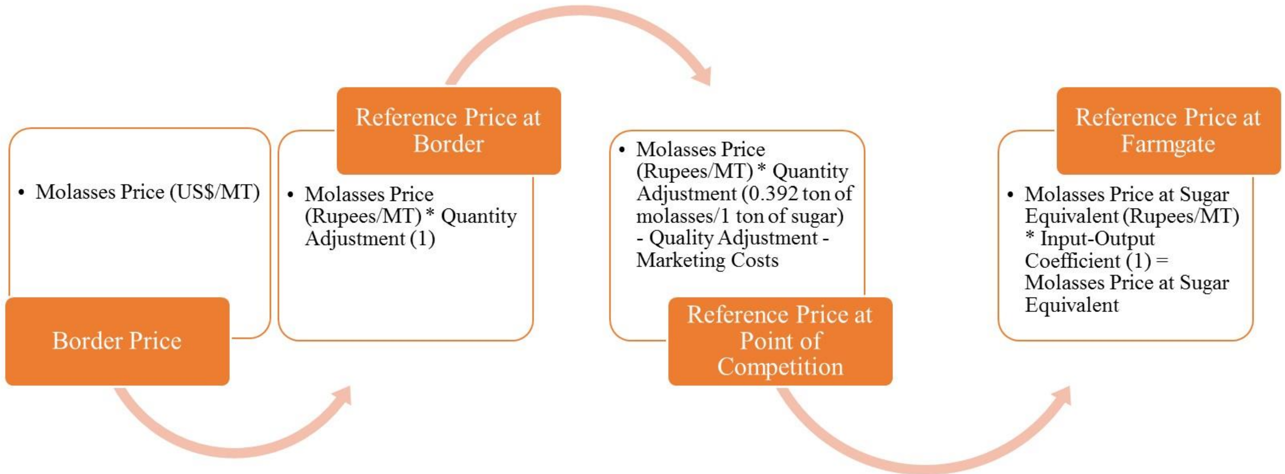
Appendix Figure 8 Price Transmission for Molasses along the Ethanol-Molasses Value Chain



Appendix Figure 9 Price Transmission for Ethanol along the Ethanol-Molasses Value Chain



Appendix Figure 10 Price Transmission for Molasses along the Ethanol-Molasses Value Chain



7.4 NRP with Policy

Appendix Figure 11 Change in NRP due to Policy