Abstract

In this paper we build a simple theoretical trade model of Ricardian type. We consider a two country - two commodity framework, where both the commodities are produced by using labour alone. Labour is assumed to be heterogeneous. We define poverty in terms of food insecurity. Then we proceed to see how trade affects different individuals of different countries. In presence of single voting right, we see the conditions under which trade may take place.
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Opening up of the Agricultural sector in the Presence of Single Voting Rights*

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1 Introduction

Ever since the formation of the World Trade Organization (WTO), free trade in agricultural goods has been the subject of controversy. Indeed, on several occasions, WTO negotiations have broken down primarily because the negotiating nations have failed to reach a consensus regarding the opening up of trade in agricultural goods. The dispute is about the removal of agricultural subsidies. Governments of advanced countries have been showing remarkable reluctance to reduce the huge subsidies they give on their agricultural sectors. This, in turn, has created an unfair competition for potential third world exporters of agricultural goods to first world markets. In fact, first world agricultural subsidies have not only restricted foreign competition in their home agricultural markets, but sometimes have been so high that the subsidy-ridden agricultural product from the first world is *exported* to the third world. Agricultural sectors of third world countries are also subsidized. These countries, however, are given some concessions by the WTO in the sense that they are allowed to gradually remove their agricultural subsidies and prepare themselves for free world competition in successive stages.

Be that as it may, text book international trade theory suggests that gains from trade will outweigh the loss from it, even when it hurts some individuals. How do we then explain the lack of trade in the agricultural sector? One explanation can be provided in terms of lobbying. It is often argued that small groups can lobby more effectively than large groups. When a small group is successfully lobbying with the government, the benefit it extracts is divided among the small number of people belonging to that group so that each member gets a non-significant amount of benefit. Of course, this benefit must come at the cost of someone else. If this cost is distributed among a large number of people, each shouldering an insignificant amount of the cost and hence almost unaware of its burden, the lobbying activity has a high chance of success. In North America, Europe and Japan a very small fraction of the labour force, between 2 per cent and 4 per cent, are engaged in the agricultural sector. These small groups can spend resources on lobbying and reap the consequent benefits at the cost of a large number of consumers who are neither organized as groups nor aware of the small costs each is bearing. Mayer (1984) [8] has formalized this aspect of lobbying and protection by using the median voter theorem in a specific factor model of international trade. A follow up model has been constructed in Swinnen (1994) [11]. The prevalent protection in agriculture has prompted studies of global model as listed by Tongeren, Meijl and Surry (2001) [3]. These models do not view protection as an optimal policy from the point of view of the society or consumers and imply that trade restrictions, arising out of lobbying of small groups, as basically undesirable.

Free trade may often hurt the economy if we move away from the standard neo-classical literature on trade. Newbery and Stiglitz (1981) [9] and Shy (1988) [10] show in presence of production uncertainty and risk averse individuals trade can be Pareto inferior. Krugman and Venables (1995) [6] have shown that trade may hurt when there is increasing returns and transport cost. Lancaster(1980) [7]

shows there will be no agricultural trade in presence of monopolistic competition, there need not be any agricultural trade if it is undifferentiated. Costinot and Vogel (2010) [2] use a matching model to show that trade will increase within group and between group inequality in a skill-abundant country, but will reduce the same in the skill-scarce country. However, whether trade will increase inequality in a skill-abundant country remains a debatable empirical issue. For example, Dollar (2005) shows that increased trade has no effect on inequality [4]. Krishna and Yavas (2005) [5] have shown that in a transition economy in presence of heterogeneous labour and consumption indivisibility, trade might be Pareto inferior.

Agricultural goods are different from industrial goods in many respects and standard models in international trade theory often do not capture those differences. Both demand side and the supply side of the agricultural sector might behave quite differently from the manufacturing sector. On the supply side, agricultural sector is affected by presence of uncertainty in the production structure, as crops depend heavily on the state of nature. Even with an advanced technology in developed countries like Australia, it has been found that crops are severely affected by drought. On the demand side, it is a necessary commodity. Or there can be indivisibility of consumption. Most importantly, it is related to the issue of food security, which is a prime concern for the policy makers around the world. It is not possible to capture all the possible complexities in a single model, and hence, here we build a simple two sector two country Ricardian model addressing to the issue of food security and labour heterogeneity. We try to see the effect of trade in agriculture on inequality and poverty. According to Food and Agriculture Organization of the United Nations (FAO), food insecurity is closely related to absolute poverty. In our paper, we consider a pre-determined food security threshold, as talked about in the report Impacts of Policies on Poverty by FAO [1]. We also assume labour to be heterogeneous in terms of productivity. In section 2 we build the basic model and see the result under autarky and free trade. We also see the effect of free trade on different countries. Section 4 shows under what condition a country might go for trade. Section 5 concludes the paper.

2 The Model

The Economy

We begin with an economy consisting of individuals who own only labour. Two goods can be produced in the economy using labour, viz., an industrial good x and an agricultural good y. To produce one unit of agricultural good individuals require one unit of labour. However productivity of labour in x sector varies from individual to individual. An individual can produce ϕ units of x using 1 unit of labour. We assume that ϕ follows a continuous uniform distribution, with the support $[\underline{\phi}, \bar{\phi}]$. This assumption can be looked at in the lights of the assumption of effective labour in Krishna and Yavas (2005). Price of good x is normalized to 1. Each individual is endowed with 1 unit of labour, which they can decide to employ either in x sector or in y sector. Individuals get satiated in the consumption of food after a certain level

$\bar{y}$. Utility function is broadly Cobb-Douglas type which becomes non-homothetic beyond $\bar{y}$. Once an individual can afford to consume $\bar{y}$, she starts spending the excess income solely on the industrial good. We loosely characterize those who can consume $\bar{y}$ level of agricultural good as rich and others as poor. In other words, we define poverty as the inability to consume a certain level of food and hence nutrition. However, since we are in a static model, we assume away the possibility of a subsequent decline in the productivity level due to insufficient consumption of food. The following is the utility function:

$$U = \begin{cases} x^a y^{1-a} & \text{if } y < \bar{y} \\ x^a \bar{y}^{1-a} & \text{if } y \geq \bar{y} \end{cases} \tag{1}$$

The individual will maximize equation (1) subject to the following budget constraint:

$$x + p_y y = \alpha\phi + p_y(1 - \alpha) \tag{2}$$

The demand for the agricultural good then will be given by:

$$y^d = min\{\bar{y}, \frac{1-a}{p_y}(\alpha\phi + (1-\alpha)p_y)\}$$

The Indirect Utility Function is essentially an increasing function of income. Therefore, maximization of the indirect utility function can be achieved by maximizing income by choosing how much labour to allocate in each sector. Let I be the income.

$$I = \alpha\phi + (1-\alpha)p_y$$

Maximizing I w.r.t. α we see that

$$\alpha = \begin{cases} 1 & \text{if } p_y < \phi \\ 0 & \text{if } p_y > \phi \end{cases} \tag{3}$$

Individuals who specialize in y sector will be able to consume $1 - a$ units of food. We assume that $\bar{y} > 1 - a$ which would ensure the existence of poverty in the economy. Otherwise, everyone in the economy will be able to consume $\bar{y}$. Individuals in the x sector consume $(1 - a)\phi/p_y$ of the agricultural good. Critical value of ϕ for which an individual in x sector can just consume $\bar{y}$ is given by $\tilde{\phi}$. $\tilde{\phi}$ must satisfy $\bar{y} = \frac{1-a}{p_y}(\tilde{\phi})$. Therefore, we have,

$$\tilde{\phi} = \frac{\bar{y}p_y}{a} > p_y = \hat{\phi}$$

where $\hat{\phi}$ is the ϕ for which an individual is indifferent between production in x sector and y sector. For $\phi > \tilde{\phi}$, individuals will consume $\bar{y}$ amount and hence can be considered as rich. Those who get engaged in agriculture are all poor, while those who are in the industrial sector may or may not be poor, depending on their productivity in the industrial sector.

Equilibrium under Autarky

The equilibrium price under autarky will be obtained by equating demand and supply. We consider only the market for y. Then by virtue of Walras Law, the x market will also be in equilibrium.

Demand for y:

$$\int_{\underline{\phi}}^{p_y}(1-a)d\phi+\int_{p_y}^{\frac{\bar{y}p_y}{1-a}}\frac{(1-a)\phi}{p_y}d\phi+\int_{\frac{\bar{y}p_y}{1-a}}^{\bar{\phi}}\bar{y}d\phi$$

The first term is the demand made by the individuals in the agricultural sector, the second term is the demand made by the poor of the industrial sector and the third term is the demand made by the non-poor of the industrial sector.

Supply of y:

$$\int_{\underline{\phi}}^{p_y}d\phi$$

Under autarky, supply of y = demand for y. Simplifying we get

$$(1-a)(p_y-\underline{\phi})+\frac{\bar{y}^2p_y}{2(1-a)}-\frac{(1-a)p_y}{2}+\bar{y}\bar{\phi}-\frac{\bar{y}^2p_y}{(1-a)}=(p_y-\underline{\phi}) \tag{4}$$

Solving equation (4) we get the autarkic price level

$$p_y=\frac{2(1-a)(\bar{y}\bar{\phi}+a\underline{\phi})}{2(1-a)+\bar{y}^2+(1-a)^2} \tag{5}$$

In order to have a meaningful equilibrium (i.e., both the products are produces in equilibrium) we require the following inequality

$$\underline{\phi}<p_y<\tilde{\phi}<\bar{\phi}$$

The above inequality will be guaranteed if we have

$$\frac{\bar{\phi}}{\underline{\phi}}>\frac{(1-a)^2+\bar{y}^2}{2(1-a)\bar{y}}$$

3 Free Trade

We consider two countries A and B. In both the countries the productivity in sector y is unity. In country A, productivity of each individual in sector x is given by ϕ_A, where ϕ_A follows a continuous uniform distribution with support $[\underline{\phi}_A,\bar{\phi}_A]$. In country B, productivity of each individual in sector y is given by ϕ_B, where ϕ_B follows a continuous uniform distribution with support $[\underline{\phi}_B,\bar{\phi}_B]$. Trade takes between A and B. First we will determine the international price p^* by equating world demand to world supply. We denote the autarkic price of y in country A by p_A and that of country B by p_B. Let us assume that $p_A<p_B$ by suitable choice of parameters. In

order to ensure $p_A < p_B$ we simply need to assume $\underline{\phi}_A < \underline{\phi}_B$ and $\bar{\phi}_A < \bar{\phi}_B$. World demand for the agricultural good is now given by

$$\int_{\underline{\phi}_A}^{p^*}(1-a)d\phi_A + \int_{p_y}^{\frac{\bar{y}p^*}{1-a}}(1-a)\phi_A d\phi_A + \int_{\frac{\bar{y}p^*}{1-a}}^{\bar{\phi}_A}\bar{y}d\phi_A$$
$$+ \int_{\underline{\phi}_B}^{p^*}(1-a)d\phi_B + \int_{p^*}^{\frac{\bar{y}p^*}{1-a}}(1-a)\phi_B d\phi_B + \int_{\frac{\bar{y}p^*}{1-a}}^{\bar{\phi}_B}\bar{y}d\phi_B$$

World supply is given by

$$\int_{\underline{\phi}_A}^{p^*} d\phi_A + \int_{\underline{\phi}_B}^{p^*} d\phi_B$$

Equating world demand for y with the world supply of y and simplifying, we get

$$(1-a)p^* - (1-a)(\underline{\phi}_A + \underline{\phi}_B) + \bar{y}(\bar{\phi}_A + \bar{\phi}_B) - \frac{\bar{y}^2 p^*}{1-a} = 2p^* - (\underline{\phi}_A + \underline{\phi}_B) \quad (6)$$

We can solve for p^* from (6).

$$p^* = \frac{a(1-a)(\underline{\phi}_A + \underline{\phi}_B) + (1-a)\bar{y}(\bar{\phi}_A + \bar{\phi}_B)}{2(1-a) - (1-a)^2 + \bar{y}^2} \quad (7)$$

We can see that $p^* = \frac{1}{2}(p_A + p_B)$ from (7). This will mean that $p_B > p^* > p_A$. Therefore, country A has a comparative advantage in good y and B in good x. In extreme cases there can be complete specialization. However, that can be extended as a special case. Here there is complete specialization at individual level, but there need not be complete specialization on account of difference in productitivity. We would like to see the possible effects of a change in price on country A. With an increase in agricultural price, the agricultural sector will expand in size while the industrial sector will reduce in size. The agricultural income will increase while the industrial income remains unchanged. Those who shift from industry to agriculture will experience an increase in income.

Let us see the effect of change in price on income and consumption in each of these two countries. In table 1 we see the effect of an increase in agricultural price on the income and consumption of people with various productivity in country A as the country moves from autarky to free trade. Table 2 shows the same for country B when it moves from autarky to free trade and experiences a decrease in the agricultural price by virtue of having comparative advantage in the industrial good.

It is evident from table 1 and table 2 that in the the country with a comparative advantage in the agricultural good, poverty will increase as the number of people getting to have $\bar{y}$ amount of x reduces under free trade. In the country with comparative advantage in the industrial good, though poverty decreases in terms of food consumption, inequality increases. We measure poverty using head count and inequality using Gini Coefficient.

Lemma 3.1. *Gini coefficient increases as the agricultural price increases.*

Proof. Let us define a variable z such that $z = max\{p_y, \phi\}$, where p_y is the agricultural price, and hence the agricultural income and ϕ the productivity and hence the income in the industrial sector. Therefore, z is the income of a representative individual of the economy described in section 2. Let $z \in [\underline{z}, \infty]$, where $\underline{z} = max\{p_y, \phi\}$. We can see that $\underline{z}$ is non-decreasing in p_y. Let z follow a distribution function $F(z)$ and density function $f(z)$. The Gini Coefficient is given by

$$G = \frac{1}{\mu} \int_{\underline{z}}^{\infty} F(z)(1 - F(z))dz$$

where μ is the mean of the distribution of z. Clearly, μ is non-decreasing in p_y.

$$G = \frac{1}{\mu} \int_{\underline{z}}^{\infty} (F(z) - F(z)^2)dz \tag{8}$$

Differentiating 8 w.r.t. $\underline{z}$ we get

$$\frac{\partial G}{\partial \underline{z}} = -\frac{1}{\mu^2} \left(\int_{\underline{z}}^{\infty} (F(z) - F(z)^2)dz \right) \frac{\partial \mu}{\partial \underline{z}} - \frac{1}{\mu} F(\underline{z})(1 - F(\underline{z})) < 0 \tag{9}$$

Therefore, an increase in $\underline{z}$ will reduce the Gini. We know that z in non-increasing in p_y. Hence we can conclude that an increase in p_y will reduce the gini. □

On the basis of the above lemma we make the following proposition.

Proposition 3.1. *In country A inequality will increase while in country B inequality will decrease in terms of gini with opening up of trade.*

Country A with comparative advantage in y will experience in increase in agricultural price while country B with a comparative advantage in x will experience a fall in agricultural price. Then following lemma 3.1 we get the above proposition.

Proposition 3.2. *In country A the number of poor people increase. In country B the number of poor people decrease.*

Conventional wisdom suggests that traditionally poor countries which are agriculture dependent should have lower inequality as our result shows. However, colonial past and other factors have made some countries poor and unequal. We use the following diagrams to see the comparisons of utility and income under autarky and free trade. Figure 1 shows the case when the country has a comparative advantage in the agricultural good, and figure 2 shows the case for the industrially advanced country.

Table 1: Effect of Trade on Country A, comparative advantage in agricultural goos y

Range of ϕ	Change in Specialization	Consumption of y	Consumption of x	Utility
$\underline{\phi}_A$ to p_A	Continues to specialize in y	Remains at $1-a$	Increases from ap_A to ap^*	Increases
p_A to p^*	Changes from x to y	Falls from $\frac{(1-a)\phi_A}{p_A}$ to $1-a$	Increases from $a\phi_A$ to ap^*	Increases till $\tilde{\tilde{\phi}}_A$, then falls[a]
p^* to $\frac{\bar{y}p_A}{1-a}$	Continues to specialize in x	Falls from $\frac{(1-a)\phi_A}{p_A}$ to $\frac{(1-a)\phi_A}{p^*}$	Remains at $a\phi_A$	Decreases
$\frac{\bar{y}p_A}{1-a}$ to $\frac{\bar{y}p^*}{1-a}$	Continue to specialize in y	Falls from $\bar{y}$ to $\frac{a\phi_A}{p^*}$	Falls from $\phi_A - p_A\bar{y}$ to $b\phi_A$	Decreases
$\frac{\bar{y}p^*}{1-a}$ to $\bar{\phi}_A$	Continue to specialize in y	Remains at $\bar{y}$	Falls from $\phi_A - p_A\bar{y}$ to $\phi_A - p^*\bar{y}$	Decreases

[a]See Appendix

Table 2: Country B

Range of ϕ	Specialization	Consumption of y	Consumption of x	Utility
$\underline{\phi}_B$ to p^*	Continue to specialize in y	Remains at $1-a$	Decreases from ap_B to ap^*	Decreases
p^* to p_B	Changes from y to x	Rises from $1-a$ to $\frac{(1-a)\phi_B}{p^*}$	Decreases from $a\phi_B$ to ap^*	Decreases till $\tilde{\tilde{\phi}}_B$, then rises[a]
p_B to $\frac{\bar{y}p^*}{1-a}$	Continue to specialize in x	Rises from $\frac{(1-a)\phi_B}{p_B}$ to $\frac{(1-a)\phi_B}{p^*}$	Remains at $a\phi_B$	Increases
$\frac{\bar{y}p^*}{1-a}$ to $\frac{\bar{y}p_B}{1-a}$	Continue to specialize in x	Rises from $\frac{(1-a)\phi_B}{p_B}$ to $\bar{y}$	Rises from $a\phi_B$ to $\phi_B - p_B\bar{y}$	Increases
$\frac{\bar{y}p_B}{1-a}$ to $\bar{\phi}_A$	Continue to specialize in x	Remains at $\bar{y}$	Rises from $\phi_B - p_B\bar{y}$ to $\phi_B - p^*\bar{y}$	Increases

[a]See Appendix

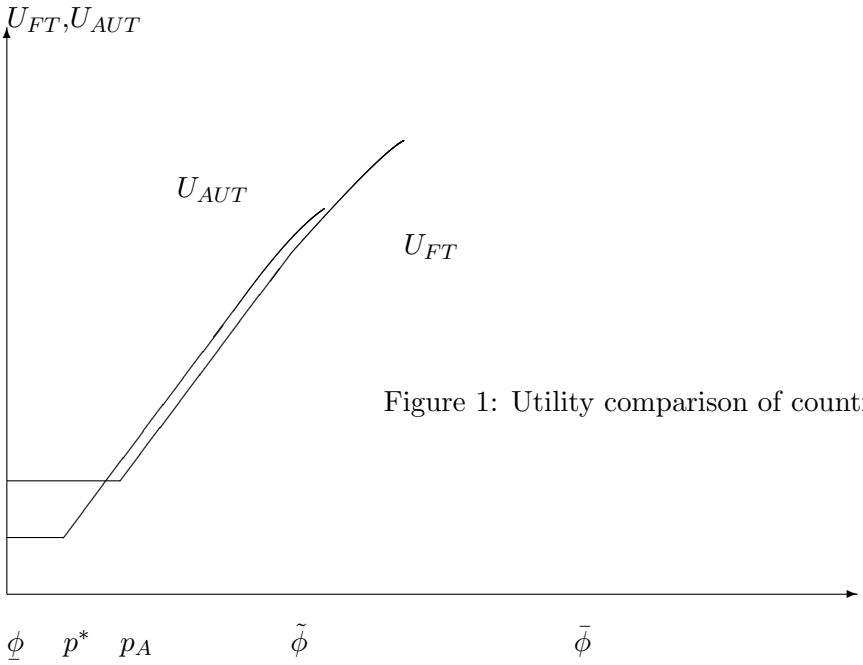

Figure 1: Utility comparison of country A

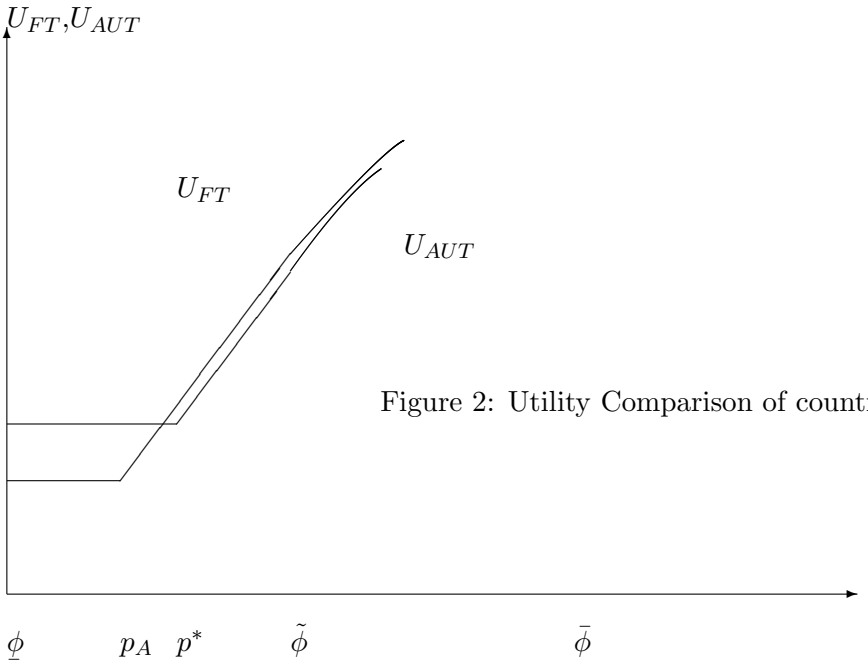

Figure 2: Utility Comparison of country B

4 When will there be Trade

In a two country framework trade can take place when both the countries agree to open up. It is seen that in both the countries some people will gain from trade while some will lose. A country will go for liberalization if the number of people gaining from free trade is greater than the number of people losing. We assume that each individual has a single vote. They will vote for the policy if their utility increases otherwise they will vote against the the policy. Whether or not the country will open up will depend on majority voting. If majority vote against free trade, the country would choose not to open up and vice versa. The number of people which vote for the policy in country A is given by

$$\int_{\underline{\phi}_A}^{\tilde{\tilde{\phi}}_A} \frac{d\phi_A}{\bar{\phi}_A - \underline{\phi}_A}$$

The number of people voting against the policy in country A is given by

$$\int_{\tilde{\tilde{\phi}}_A}^{\bar{\phi}_A} \frac{d\phi_A}{\bar{\phi}_A - \underline{\phi}_A}$$

The country will opt for trade when the first expression is greater than the second one. In other words, country A will go for free trade when $2\tilde{\tilde{\phi}}_A > \bar{\phi}_A + \underline{\phi}_A$. We have seen from equation 6 that $p^* = \frac{1}{2}(p_A + p_B)$ and $\tilde{\tilde{\phi}}_A = p_A^{1-a} p^{*a}$ (see Appendix). So $p^* > \tilde{\tilde{\phi}}_A > p_A$. Since $\tilde{\tilde{\phi}}_A > p_A$ it is sufficient to show that $2p_A > \bar{\phi}_A + \underline{\phi}_A$. Therefore, we can conclude that if the autarkic price is greater than the average productivity in the industrial sector, the country will open up for trade.

The number of people who vote against the policy in country B is given by

$$\int_{\underline{\phi}_B}^{\tilde{\tilde{\phi}}_B} \frac{d\phi_B}{\bar{\phi}_B - \underline{\phi}_B}$$

The number of people voting for the policy in country B is given by

$$\int_{\tilde{\tilde{\phi}}_B}^{\bar{\phi}_B} \frac{d\phi_B}{\bar{\phi}_B - \underline{\phi}_B}$$

The country will opt for trade when the first expression is less than the second one. In other words, country B will go for free trade when $2\tilde{\tilde{\phi}}_B < \bar{\phi}_B + \underline{\phi}_B$. We know from equation 6 that $p^* = \frac{1}{2}(p_A + p_B)$ and $\tilde{\tilde{\phi}}_B = p_B^a p^{*1-a}$ (See Appendix). So $p^* < \tilde{\tilde{\phi}}_B < p_B$. Since $\tilde{\tilde{\phi}}_B < p_B$ it is sufficient to show that $2p_B < \bar{\phi}_B + \underline{\phi}_B$ Therefore, we can conclude that if the autarkic price is less than the average productivity in the industrial sector, the country will open up for trade.

On the basis of the discussion above, we make the following proposition.

Proposition 4.1. *A country with comparative advantage in agriculture (industry) will open up for trade if the autarkic agricultural price is greater (less) than the average productivity in the industrial sector.*

It is evident that countries need not have any incentive to open up for trade, as situations may arise when the question of food security arises and when all the population is not homogeneous. Since we are in a two-country framework, if one country prefers to remain in autarky, the other country automatically has to remain in autarky.

5 Conclusion

We build a very simple model to see the effect of trade in different countries. In a two country framework with heterogeneous agents we see that poverty, measured in terms of food security, increases in the country with comparative advantage in agriculture, while inequality increases in the country with comparative advantage in industry with the opening up of trade. We also see that both the countries may choose not to participate in trade as it might hurt the majority. This paper is an attempt to explain lack of free trade in agriculture world wide, without resorting to literature of lobbying.

Appendix

Country A

People in country A with productivity lower than $\tilde{\tilde{\phi}}_A$ will gain from trade and those with higher productivity will lose. Those who continue to remain in the agricultural sector gain from trade as their income rise. Those who shift from the industry to agriculture experience an increase in income at a lower level of productivity while those with higher productivity will experience a loss of utility as now they pay more for the same amount of food. The autarkic utility level is given by $U_{AUT} = a^a(1-a)^{(1-a)}p_A^{-(1-a)}\phi_A$ and the utility under trade is $U_{FT} = a^a(1-a)^{(1-a)}p^{*a}$. Comparing utility we can see that utility rises till $\phi_A = p_A^{1-a}p^{*a} = \tilde{\tilde{\phi}}_A$, beyond that it starts falling.

Country B

People in country B with productivity higher than $\tilde{\tilde{\phi}}_B$ will gain from trade and those with lower productivity will lose. Those who relocate from the agricultural sector to the industrial sector lose from trade as their income falls at a lower level of productivity, but at higher productivity the individuals will gain. The autarkic utility level is given by $U_{AUT} = a^a(1-a)^{1-a}p_B^a$ and the utility under trade is $U_{FT} = a^a(1-a)^{1-a}p^{*-(1-a)}\phi_B$. Comparing utility we can see that utility falls till $\phi_B = p_B^a p^{*1-a} = \tilde{\tilde{\phi}}_B$, beyond that it starts rising.

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