Agricultural Trade with Production Uncertainty *

Debasmita Basu †
Abhirup Sarkar

Economic Research Unit,
Indian Statistical Institute,
203, B. T. Road,
Kolkata-700108

Abstract

Uncertainty in agricultural production resulting in loss of insurance works against standard gains from trade through comparative advantage. The strength of these two forces determine the final effect of trade on welfare. If gains from trade is strong enough, utility under free trade is higher than that under autarky. Even when comparative advantage effects are not strong enough such that free trade is worse than autarky, there exists a tax-subsidy scheme which with trade always makes the country better off than autarky. If a country specializes completely in a good which exhibits no uncertainty, it unambiguously gains from free trade. Countries with strong comparative advantage in industrial goods where production is less uncertain, have no reason to restrict agricultural trade. Countries with strong comparative advantage for agricultural goods have reasons for government intervention which provides insurance. For all countries, some trade (free or restricted) is better than no trade.
JEL Classification: F10, F13, D81, Q17, Q18
Keywords: Trade; Welfare; Protection; Uncertainty; Agriculture in International Trade; Agricultural policy

*We would like to thank everyone attending the annual evaluation seminar in the Indian Statistical Institute and Econophys - Kolkata V. However, the usual disclaimer applies.
†Email: debasmita_r@isical.ac.in

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 subsidies are usually inefficient and more so, when subsidized products are exported. Subsidies not only distort prices but when subsidy-ridden goods are exported abroad, foreign consumers benefit at the cost of domestic tax payers. How do we then explain the obstinate stance of countries, both developed and less developed, about sticking to their subsidy policies as far as agricultural goods are concerned? 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) [9] 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) [13]. 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.

There is yet another route of explaining restrictions on the free international flow of agricultural goods. Due to its dependence on uncontrollable natural factors like weather or rainfall, on an average, agricultural production exhibits higher uncertainty than industrial production. Again, there is an established literature on trade and uncertainty which demonstrates the various ways in which gains from free trade can be diminished if uncertainty is present. The two can be put together to build up an argument in favour of restricted trade in agricultural goods. The present paper is a step in that direction.

There are two groups of literature dealing with international trade under uncertainty. The relatively older of the two, consisting of the works of Kemp and Liviatan (1973) [8], Ruffin (1974) [11], Batra and Russel (1974) [2], Turnovsky (1974) [14], Batra (1975), Eaton (1979) [3] and others asks how uncertainty in either production or terms of trade affects the level of welfare and trade of a country. It also looks at the determinants of comparative advantage and the pattern of trade. Most of the papers in this genre consider uncertainty in terms of trade. Eaton and Grossman (1985) [4] find out the optimal intervention by the government in the form of tariff (second best scenario, the first best being tax-subsidy) in presence of uncertain terms of trade. As a sequel, Helpman and Razin (1978) [7], Helpman (1988) [6] and Grossman and Razin (1985) [5] extended the basic trade model in presence of uncertainty to incorporate trade in securities. Apart from looking into the question of comparative advantage under uncertainty,these models were concerned with finding out the change in Welfare once uncertainty is introduced or the degree of uncertainty goes up, but did not get into a direct comparison of autarky and trade under uncertainty (for example, Turnovsky compares utility in a certain environment vis-a-vis that in an uncertain environment in presence of trade). The second group of research does exactly that. In a partial equilibrium framework, Newbery and Stiglitz (1984) [10] demonstrates the possibility that autarky welfare might be unambiguously higher than that under trade. Shy (1988) [12] has extended the Newbery-Stiglitz partial equilibrium to general equilibrium. The present paper uses the Newbery-Stiglitz-Shy framework to probe further into autarky-trade comparison with a view to understand the desirability of trade in agricultural goods the production of which is intrinsically uncertain.

Newbery and Stiglitz considers trade between two countries which are ex ante identical, but ex post different. The difference arises because of different realizations of the ex ante uncertain states in one of the sectors, say, the agricultural sector. Under autarky, due to downward sloping demand, a bad state leading to low agricultural output implies high prices and a good state of high output implies low prices. Hence agricultural income, which is the product of price and quantity, does not fluctuate much across states. In fact it remains constant if the demand curve has unit elasticity, as assumed in the Newbery and Stiglitz paper. Therefore, downward sloping demand in the domestic market provides a natural *insurance* to risk averse agents. As trade opens up, the international price remaining constant, fluctuating agricultural output leads to fluctuating agricultural income which makes agriculture less attractive to agents who are risk averse. As a result, investment in agriculture goes down to a sub-optimal level and overall welfare under free trade becomes lower than that under autarky.

From this argument it is, however, not correct to conclude that autarky is better than free trade whenever there is uncertainty in the production of one of the goods.

Indeed, the Newbery-Stiglitz framework assumes away any comparative advantage of the trading countries by making them ex ante identical. Thus the standard channels of gains from trade are closed down by assumption. This is done purposefully to focus entirely on the loss of insurance aspect of free trade. But if we wish to examine the desirability of trade in agricultural goods exhibiting significant uncertainty we have to weigh the costs due to insurance loss from trade with natural gains from comparative advantage. If the latter outweighs the former, then there has got to be positive gains from free trade.

In this paper we allow both forces, namely comparative advantage and loss of insurance, to interact against each other to determine the final effect of trade on welfare. We show that if gains due to comparative advantage is strong enough, free trade dominates autarky in terms of utility, which we have taken to be the measure of welfare. Moreover, even when comparative advantage effects are not strong enough so that free trade yields lower welfare than no trade, we find a tax-subsidy scheme which along with trade always makes the country better off than autarky. We also show that if a country gets completely specialized in a good which exhibits no uncertainty, it unambiguously gains from free trade. From all this we conclude that restricted agricultural trade, as it is practised in the world at present, cannot always be justified on grounds of welfare, though some intervention in the agricultural market may be necessary. Our analysis implicitly suggests that lobbying as opposed to uncertainty may be a better way to understand the lack of agricultural trade in the present day world. In section 2 of our paper we build a formal two sector small open economy with production uncertainty in the agricultural sector. We show that free trade might be pareto inferior to autarky, which opens up a route for government intervention. In section 3 we introduce government intervention in the form of providing complete insurance to the agricultural sector. In section 4 we compare our model with that of Shy (1988). Section 5 concludes the paper.

2 The Model

We begin with a small open economy producing two goods, one industrial good x (safe good) and one agricultural good y (risky good) using labour, unlike Shy (1988), where large open economies are considered. In section 4 we will consider a two country framework and compare our findings with those in Shy (1988). The amount of labour in the economy is normalized to 1. Our model differs from Shy (1988) by assuming labour is perfectly divisible. The proportion of labour that goes into the safe sector is α, which is to be determined endogenously before the uncertainty is resolved. As long as the marginal expected utility from being employed in one sector is greater than the marginal expected utility from being employed in the other is higher, more labour will enter the former sector, till marginal utility of the sectors are equalized. The utility function is Cobb-Douglas type, and individuals are risk averse, with constant relative risk aversion. The indirect utility function is, therefore, given by $\frac{1}{1-\rho}\left(wp_x^{-a}p_y^{-b}\right)^{1-\rho}$, where w is the income (here we assume that income comes only from wage earning) of the individual, p_x is the price of good x and p_y is the price of good y and $\rho \neq 1$ is the degree of relative risk aversion. Individuals maximize the indirect utility function by choosing α, the proportion of labour that goes in the safe sector. On the production side, 1 unit of labour is required to produce one unit of good x. However, the production of agricultural good is uncertain depending on the state of nature. 1 unit of labour can produce θ_H units of y in the high state, while 1 unit of labour can produce θ_L units in low state. Therefore, the wage in x sector is 1 and that in y sector is $\theta_H p_y^H$ in high state and $\theta_L p_y^L$ in low state, where p_y^H is the price of god y in high state and p_y^L is the price of the same in the low state. High state occurs with probability π and low state occurs with probability $1-\pi$, and $0<\pi<1$. In the following subsections we will compare the welfare under autarky to that under free trade in a static framework with no future.

2.1 Autarky

Let us characterize the equilibrium under autarky. Under autarky, the high state wage w_H will be given by $\left(\alpha+(1-\alpha)\theta_H p_y^H\right)$, the low state wage w_L will be given by $\left(\alpha+(1-\alpha)\theta_L p_y^L\right)$. Therefore, the expected indirect utility will be given by

$$EV_{AUT} = \left(\frac{\pi}{1-\rho}\right)\left(p_y^{H^{-b}}\left(\alpha+(1-\alpha)\theta_H p_y^H\right)\right)^{1-\rho} + \left(\frac{1-\pi}{1-\rho}\right)\left(p_y^{L^{-b}}\left(\alpha+(1-\alpha)\theta_L p_y^L\right)\right)^{1-\rho} \quad (1)$$

Relative supply is given by $\alpha/(1-\alpha)\theta_H$ in high state and $\alpha/(1-\alpha)\theta_L$ in the low state. Using Roy's identity to the indirect utility function, relative demand is found to be ap_y^H/b in the high state and ap_y^L/b in the low state. At equilibrium, relative demand will be equal to relative supply in each state since market has to clear in each state. Under autarky, both the goods will be produced.

$$\frac{\alpha}{1-\alpha} = \frac{ap_y^H\theta_H}{b}$$

and

$$\frac{\alpha}{1-\alpha} = \frac{ap_y^L\theta_L}{b}$$

in high and low state respectively.

The choice of α is ex ante implying $p_y^H\theta_H = p_y^L\theta_L$. Therefore, equation (1) can be written as

$$EV_{AUT} = \left(\frac{\alpha}{a}\right)^{a(1-\rho)}\left(\frac{1-\alpha}{b}\right)^{b(1-\rho)}\left(\frac{\pi\theta_H^{b(1-\rho)}}{1-\rho} + \frac{(1-\pi)\theta_L^{b(1-\rho)}}{1-\rho}\right) \tag{2}$$

Differentiating (2) w.r.t. α and setting the derivative to 0, we get $\alpha^* = a$, where α^* is the optimal allocation of labour. Therefore, the autarkic expected indirect utility at equilibrium is given by

$$EV_{AUT} = \frac{1}{1-\rho}\left(\pi\theta_H^{b(1-\rho)} + (1-\pi)\theta_L^{b(1-\rho)}\right) \tag{3}$$

$\alpha = a$ is a Pareto optimal allocation of resources in the sense that had there been a social planner given the task to allocate resources would have chosen the optimal labour allocation equal to a. This result is identical to the one shown in Shy (1988). In other words, the assumption of indivisibility of labour does not change the autarkic labour allocation.

2.2 Free Trade

When trade opens up the small open economy takes the international price to be given exogenously. We assume that there is no price uncertainty. Therefore, price will be equal across the states for a small open economy. Let the world price for the agricultural sector be p_y. The expected indirect utility function can now be written as

$$\begin{aligned} EV_{FT} = & \frac{\pi}{1-\rho}p_y^{-b(1-\rho)}(\alpha + (1-\alpha)\theta_H p_y)^{1-\rho} \\ & + \frac{1-\pi}{1-\rho}p_y^{-b(1-\rho)}(\alpha + (1-\alpha)\theta_L p_y)^{1-\rho} \end{aligned} \tag{4}$$

Individuals maximize (4) over α, i.e., the labour allocation, as before. Differentiating RHS of equation (4) w.r.t. α we get

$$\frac{\partial EV_{FT}}{\partial \alpha} = p_y^{-b(1-\rho)}(\pi(\alpha + (1-\alpha)\theta_H p_y)^{-\rho}(1 - p_y\theta_H) + (1-\pi)(\alpha + (1-\alpha)\theta_L p_y)^{-\rho}(1 - p_y\theta_L)) \tag{5}$$

Uncertainty in the production structure and ex ante allocation of resources may lead to incomplete specialization rather than complete specialization we see in standard Ricardian Model.

2.2.1 Incomplete Specialization

Incomplete specialization would mean that in our model the optimal labour allocation α^* should lie between 0 and 1. Whether or not incomplete specialization will take place depends on the values of the parameters, i.e., p_y, θ_H, θ_L, π. In case of incomplete specialization, individuals will equate $\partial EV_{FT}/\partial\alpha$ with 0. This is the first order condition for maximization, rewriting which we get

$$\frac{\alpha + (1-\alpha)\theta_L}{\alpha + (1-\alpha)\theta_H} = \left(\left(\frac{1-\pi}{\pi}\right)\left(\frac{1 - p_y\theta_L}{p_y\theta_H - 1}\right)\right)^{1/\rho} \tag{6}$$

Let $\left(\left(\frac{1-\pi}{\pi}\right)\left(\frac{1-p_y\theta_L}{p_y\theta_H - 1}\right)\right)^{1/\rho} = A$.
Since $\theta_H > \theta_L$, $A < 1$ from (6). Therefore, $p_y > \frac{1}{\pi\theta_H + (1-\pi)\theta_L}$. Let us define $\underline{p}_y = \frac{1}{\pi\theta_H + (1-\pi)\theta_L}$. Solving (6) we get the value of α.

$$\alpha^* = \frac{1}{1 + \frac{1-A}{A\theta_H p_y - \theta_L p_y}} \tag{7}$$

We have already seen that $A < 1$. Therefore, for $\alpha^* < 1$ we require $A\theta_H p_y - \theta_L p_y > 0$ from (7), i.e., $p_y < \frac{\pi\theta_H^{-\rho} + (1-\pi)\theta_L^{-\rho}}{\pi\theta_H^{1-\rho} + (1-\pi)\theta_L^{1-\rho}}$.
Let us define $\overline{p}_y = \frac{\pi\theta_H^{-\rho} + (1-\pi)\theta_L^{-\rho}}{\pi\theta_H^{1-\rho} + (1-\pi)\theta_L^{1-\rho}}$.
It is easy to show that $1/\theta_H < \underline{p}_y < \overline{p}_y < 1/\theta_L$. Hence if $\underline{p}_y < p_y < \overline{p}_y$ there will exist an interior solution. Therefore, we can say, for an interior solution of α we require $\frac{1}{\theta_H} < p_y < \frac{1}{\theta_L}$ since $[\underline{p}_y, \overline{p}_y] \subset [1/\theta_H, 1/\theta_L]$.

When a risk averse small open economy with production uncertainty specializes incompletely, then the country may or may not lose from trade. We can take numerical examples to see this. If we take $\rho = 5$, $\theta_H = 10\theta_L$, $\theta_L = 0.2$, $\pi = 0.5$, $b = 0.5$, the country will lose from participation in trade. However, if we take $\theta_L = 2$, all the other values remaining unchanged, then free trade is better than autarky.

2.2.2 Complete Specialization

Let us now move on to the zone where incomplete specialization cannot take place. From section 2.2.1, it is clear that when $p_y \notin (\underline{p}_y, \overline{p}_y)$, complete specialization will take place. When $p_y\theta_L < p_y\theta_H < 1$ then $\partial EV_{FT}/\partial\alpha > 0$ for all values of α and when $1 < p_y\theta_L < p_y\theta_H$ then $\partial EV_{FT}/\partial\alpha < 0$ for all values of α. In these two cases there will be no interior solution of α. In the first case, the optimal value of α is 1, while in the second case it is 0. In other words, the country will specialize in x and y sector respectively. This is because of high comparative advantage in the respective sectors. Since we have assumed $\theta_H > \theta_L$, we can safely conclude that $p_y < \frac{1}{\theta_H}$, the country will completely specialize in x and when $p_y > \frac{1}{\theta_L}$, the country will completely specialize in y.

Proposition 2.1. *If $p_y < 1/\theta_H$ or $p_y > 1/\theta_L$ then free trade is better than autarky.*

Consider the first instance, $p_y < 1/\theta_H$. Then the country will specialize in x and expectation will not play any role here. The indirect utility will be given by

$$EV_x = \frac{p_y^{-b(1-\rho)}}{1-\rho}$$

There are two possible cases, first when $\rho > 1$ and second $\rho < 1$. In Shy (1988) whether trade will be better than autarky or not depends on whether $\rho \lesseqgtr 1$. However, in our case, it is seen that the results just not depend on the degree of risk aversion but the strength of gains from trade relative to the loss of uncertainty. It is obvious that $p_y < \frac{1}{\pi\theta_H + (1-\pi)\theta_L}$; since $p_y < \frac{1}{\theta_H}$. This will mean that

$$p_y^{-b(1-\rho)} \lesseqgtr \left(\frac{1}{\pi\theta_H + (1-\pi)\theta_L}\right)^{-b(1-\rho)} \text{ according as } \rho \gtreqless 1 \tag{8}$$

Case 1: $\rho > 1$

Define a function $f(\theta) = \theta^{-b(1-\rho)}$. We know that for this function $f' < 0$ and $f'' > 0$ when $\rho > 1$. This will mean that

$$(\pi\theta_H + (1-\pi)\theta_L)^{b(1-\rho)} < \pi\theta_H^{b(1-\rho)} + (1-\pi)\theta_L^{b(1-\rho)}$$

or,

$$\frac{1}{1-\rho}(\pi\theta_H + (1-\pi)\theta_L)^{b(1-\rho)} > \frac{1}{1-\rho}(\pi\theta_H^{b(1-\rho)} + (1-\pi)\theta_L^{b(1-\rho)}) \tag{9}$$

From the relation given by (8) we have

$$EV_x > \frac{1}{1-\rho}(\pi\theta_H + (1-\pi)\theta_L)^{b(1-\rho)} \tag{10}$$

Therefore from equations (9) and (10) we can conclude that $EV_x > EV_{AUT}$ for $\rho > 1$.

Case 2: $\rho < 1$

$$p_y^{-b(1-\rho)} > \left(\frac{1}{\pi\theta_H + (1-\pi)\theta_L}\right)^{-b(1-\rho)}$$

Therefore,

$$EV_x > \frac{1}{1-\rho}(\pi\theta_H + (1-\pi)\theta_L)^{b(1-\rho)} \tag{11}$$

Define a function

$$f(\theta) = \theta^{-b(1-\rho)}$$

For this function $f' > 0$ and $f'' < 0$ when $\rho < 1$. This means that

$$(\pi\theta_H + (1-\pi)\theta_L)^{b(1-\rho)} > \pi\theta_H^{b(1-\rho)} + (1-\pi)\theta_L^{b(1-\rho)}$$

In other words,

$$\frac{1}{1-\rho}(\pi\theta_H + (1-\pi)\theta_L)^{b(1-\rho)} > \frac{1}{1-\rho}\left(\pi\theta_H^{b(1-\rho)} + (1-\pi)\theta_L^{b(1-\rho)}\right) \tag{12}$$

Therefore we can conclude that $EV_x > EV_{AUT}$ for $\rho < 1$. Combining the two cases we prove our proposition for $\rho > 0$ but $\rho \neq 1$ in general.

Let us now suppose $p_y > \frac{1}{\theta_L}$. Then

$$EV_y = \frac{p_y^{(1-b)(1-\rho)}}{1-\rho}\left(\pi\theta_H^{1-\rho} + (1-\pi)\theta_L^{1-\rho}\right)$$

This implies

$$EV_y > \frac{\theta_L^{-(1-b)(1-\rho)}}{1-\rho}\left(\pi\theta_H^{1-\rho} + (1-\pi)\theta_L^{1-\rho}\right)$$

We know that $\theta_L^{-(1-b)(1-\rho)} \gtrless \theta_H^{-(1-b)(1-\rho)}$ when $\rho \lesseqgtr 1$.
Therefore, $\theta_L^{-(1-b)(1-\rho)}/(1-\rho) > \theta_H^{-(1-b)(1-\rho)}/(1-\rho)$ for all positive values of $\rho \neq 1$

$$EV_y > \left(\frac{\pi\theta_H^{b(1-\rho)}}{1-\rho} + \frac{(1-\pi)\theta_L^{b(1-\rho)}}{1-\rho}\right) \tag{13}$$

Equation (13) means that $EV_y > EV_{AUT}$.

When a country completely specializes in x, all the uncertainties in the economy is removed. Hence it is obvious that the country will gain unconditionally. Though the result is quite intuitive for a country specializing in the safe industrial good, this result is important in the context of a small open economy specializing in the risky agricultural good. This shows that when there is a high comparative advantage in the Ricardian sense, the gains from trade will outweigh the loss from the uncertainty and risk aversion. However, later in Section 3 we will show that in such a case free trade, though better than autarky, is not the best possible outcome.

Proposition 2.2. *A small open economy with production uncertainty will always gain from free trade when it specializes in x, which is the safe good.*

When a country specializes in x, its indirect utility function will be given by

$$EV_x = \frac{1}{1-\rho} p_y^{-b(1-\rho)}$$

Let us define a price $\widetilde{p_y}$ such that the following equality holds.

$$\frac{1}{1-\rho} \widetilde{p_y}^{-b(1-\rho)} = \left(\frac{\pi \theta_H^{b(1-\rho)}}{1-\rho} + \frac{(1-\pi)\theta_L^{b(1-\rho)}}{1-\rho} \right) \tag{14}$$

Therefore, from equation (14) we get

$$\widetilde{p_y} = \left(\pi \theta_H^{b(1-\rho)} + (1-\pi)\theta_L^{b(1-\rho)} \right)^{-\frac{1}{b(1-\rho)}}$$

$$\left(\pi \theta_H^{b(1-\rho)} + (1-\pi)\theta_L^{b(1-\rho)} \right) \lesseqgtr (\pi\theta_H + (1-\pi)\theta_L)^{b(1-\rho)}$$

according as $\rho \lesseqgtr 1$. We have already seen this while proving the previous proposition. Therefore,

$$\left(\pi \theta_H^{b(1-\rho)} + (1-\pi)\theta_L^{b(1-\rho)} \right)^{-\frac{1}{b(1-\rho)}} > \widetilde{p_y}$$

for any value of ρ.
Since EV_x is decreasing in p_y, it will mean that EV_x will always be greater than the autarkic utility.

When a risk averse small open economy specializes in y, which is the risky good, the country may or may not gain from trade. Let us now consider the case where $p_y\theta_L < 1 < p_y\theta_H$. Define a price $\widetilde{\widetilde{p_y}}$ such that the following equality holds.

$$\frac{\widetilde{\widetilde{p_y}}^{(1-b)(1-\rho)}}{1-\rho} \left(\pi \theta_H^{1-\rho} + (1-\pi)\theta_L^{1-\rho} \right) = \left(\frac{\pi \theta_H^{b(1-\rho)}}{1-\rho} + \frac{(1-\pi)\theta_L^{b(1-\rho)}}{1-\rho} \right) \tag{15}$$

$$\widetilde{\widetilde{p_y}} = \left(\frac{\pi \theta_H^{b(1-\rho)} + (1-\pi)\theta_L^{b(1-\rho)}}{\pi \theta_H^{1-\rho} + (1-\pi)\theta_L^{1-\rho}} \right)^{\frac{1}{(1-b)(1-\rho)}}$$

We know that EV_y is increasing in p_y. If the values of the parameters are such that $\widetilde{\widetilde{p_y}} < \overline{p}_y$, then free trade will always be better than autarky. However, if we take $\rho = 5$, $\theta_H = 10\theta_L$, $\theta_L = 2$, $\pi = 0.5$, $b = 0.5$, then we can show that $\widetilde{\widetilde{p_y}} > \overline{p}_y$. This will imply that the country will be worse off while specializing in y when $\widetilde{\widetilde{p_y}} > p_y > \overline{p}_y$.

If we take $\theta_L = 0.2$ instead, all the other values remaining unchanged then $\widetilde{\widetilde{p_y}} < \overline{p}_y$. This will imply that the country will never be worse off while specializing in y when $p_y \in (\widetilde{\widetilde{p_y}}, \overline{p}_y)$.

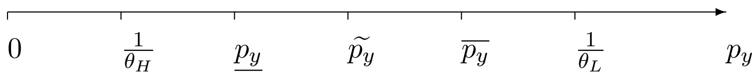

Figure 1: Price line

Figure 1 shows the range of price given which a country would decide whether to specialize completely or incompletely. If $\widetilde{\widetilde{p_y}}$ is less than $\overline{p}_y$, then the country will gain from specializing in y as compared to autarky. $\widetilde{\widetilde{p_y}}$ will either be less than or greater than $\overline{p}_y$. If $\widetilde{\widetilde{p_y}}$ is greater than $\overline{p}_y$, then the country will lose from specializing in y when $p_y \in (\overline{p}_y, \widetilde{\widetilde{p_y}})$ as compared to autarky. If $\widetilde{\widetilde{p_y}}$ is less than $\overline{p}_y$, then the country will always gain from complete specialization.

3 Restricted Trade

The fact that free trade can be inferior to autarky can justify government intervention in the risky sector. The presence of uncertainty in the production has a negative effect on the consumers' welfare because of the incompleteness of markets. Government is risk neutral and absorbs the uncertainty in the system by providing complete market in each state. Government intervention takes the form of taxing income in the high state and subsidizing in the low state. In our model, government taxes income in the high state and subsidizes income in the low state. Government announces the tax and subsidy scheme in the first stage. In high state government imposes a tax T on income and in low state it offers a subsidy S on income. On the basis of this scheme agents maximize their indirect utility in the second stage. The optimization problem can be solved using the method of backward induction. In the first step the individuals will calculate the optimal value of α given any T and S. In the second step the government will maximize the expected indirect utility with respect to its choice variables T and S. The expected indirect utility of a representative individual is given by

$$\begin{aligned} EV_{RT} = & \frac{\pi}{1-\rho}(p_y^{-b(1-\rho)}(\alpha + (1-\alpha)p_y\theta_H - T)^{1-\rho}) \\ & + \frac{1-\pi}{1-\rho}(p_y^{-b(1-\rho)}\,(\alpha + (1-\alpha)p_y\theta_L + S)^{1-\rho}) \end{aligned} \tag{16}$$

Government budget must balance in an expected sense, 1.e., the expected income of the government from taxes must be equal to its expected expenditure on subsidy. *

$$\pi T = (1-\pi)S \tag{17}$$

Proposition 3.1. *Government intervention will make trade better under a situation where free trade is Pareto Inferior to autarky.*

Substituting equation (17) in equation (16) we can rewrite the indirect expected utility in the following way.

$$\begin{aligned} EV_{RT} = & \frac{\pi}{1-\rho}\left(p_y^{-b(1-\rho)}(\alpha + (1-\alpha)p_y\theta_H - T)^{1-\rho}\right) \\ & + \frac{1-\pi}{1-\rho}\left(p_y^{-b(1-\rho)}\left(\alpha + (1-\alpha)p_y\theta_L + \frac{\pi T}{1-\pi}\right)^{1-\rho}\right) \end{aligned} \tag{18}$$

EV_{RT} is maximized by individuals given any T over α subject to the constraint that $\alpha \geq 0$. This yields an optimal value of α as

*We assume that the government starts with a fund that pays initially in case of bad states. The earnings from the good state gets deposited in the fund.

$$\alpha^* = \begin{cases} \frac{(A\theta_H - \theta_L)p_y - T\left(A + \frac{\pi}{1-\pi}\right)}{1 - A + (A\theta_H - \theta_L)p_y} & \text{if } T < \frac{(A\theta_H - \theta_L)p_y}{\left(A + \frac{\pi}{1-\pi}\right)} \\ 0 & \text{otherwise} \end{cases} \tag{19}$$

Now it is government's turn to choose T in order to maximize individuals' welfare. The government maximizes

$$\begin{aligned} EV^*_{RT} &= \frac{p_y^{-b(1-\rho)}\left(\pi^{\frac{1}{\rho}}(\theta_H p_y - 1)^{\frac{1-\rho}{\rho}} + (1-\pi)^{\frac{1}{\rho}}(1 - \theta_L p_y)^{\frac{1-\rho}{\rho}}\right)}{(1-\rho)(1-\theta_L p_y)^{1-\rho}(\theta_H p_y - 1)^{1-\rho}} \\ &\quad . \left((\theta_H - \theta_L)p_y + \frac{T}{1-\pi}(\pi\theta_H p_y + (1-\pi)\theta_L p_y - 1)\right)^{1-\rho} \end{aligned} \tag{20}$$

We see that $\frac{\partial EV^*_{RT}}{\partial T} > 0$ for all values of T. Therefore, it is inefficient for government to choose $T \leq T_{max}$ where $T_{max} = \frac{(A\theta_H - \theta_L)p_y}{\left(A + \frac{\pi}{1-\pi}\right)}$. Government announces a tax more than T_{max}. This means the country will completely specialize in y, i.e., $\alpha^* = 0$ since α is dependent on T. Now the government has to maximize the following expected indirect utility function with respect to T:

$$EV^*_{RT} = \frac{p_y^{-b(1-\rho)}}{1-\rho}\left((\pi\theta_H - T)^{1-\rho} + \left((1-\pi)\theta_L + \frac{\pi}{1-\pi}T\right)^{1-\rho}\right) \tag{21}$$

The solution to this problem will be given by $T = \pi p_y(\theta_H - \theta_L)$ In this case the indirect utility will be given by

$$EV^*_{RT} = \frac{p_y^{(1-b)(1-\rho)}}{1-\rho}(\pi\theta_H + (1-\pi)\theta_L)^{1-\rho}$$

Income in both the states will be equal to $p_y(\pi\theta_H + (1-\pi)\theta_L)$ which is greater than 1, from the condition for incomplete specialization.

$EV^*_{RT} > EV_{AUT}$

This shows that there can be an optimum intervention when there is uncertainty in production.

In the above section we have shown that an optimal intervention will make a country in autarky specialize in y, which is the risky agricultural good. Now the question that comes up following is that if an intervention will be optimal when the country completely specializes in y. From our previous proposition we can make the following corollary about that.

Corollary 3.1. *Government intervention will be the first best scenario when the country completely specializes in y.*

$$EV_y = \frac{p_y^{(1-b)(1-\rho)}}{1-\rho}\left(\pi\theta_H^{1-\rho} + (1-\pi)\theta_L^{1-\rho}\right)$$

Define a function $f(\theta) = \theta^{1-\rho}$. $f' > 0$ and $f'' < 0$ for $\rho < 1$. This means that

$$(\pi\theta_H + (1-\pi)\theta_L)^{1-\rho} > \pi\theta_H^{1-\rho} + (1-\pi)\theta_L^{1-\rho}$$

i.e.

$$\frac{1}{1-\rho}(\pi\theta_H + (1-\pi)\theta_L)^{1-\rho} > \frac{1}{1-\rho}\pi\theta_H^{1-\rho} + (1-\pi)\theta_L^{1-\rho}$$

$f' < 0$ and $f'' > 0$ for $\rho > 1$. This means that

$$(\pi\theta_H + (1-\pi)\theta_L)^{1-\rho} < \pi\theta_H^{1-\rho} + (1-\pi)\theta_L^{1-\rho}$$

i.e.

$$\frac{1}{1-\rho}(\pi\theta_H + (1-\pi)\theta_L)^{1-\rho} > \frac{1}{1-\rho}\left(\pi\theta_H^{1-\rho} + (1-\pi)\theta_L^{1-\rho}\right)$$

Hence the restricted indirect utility will always be greater than the free trade indirect utility when the country completely specializes in y.

The absence of completeness of market is responsible for trade to be inferior to autarky. Under autarky complete market is guaranteed through the demand curve which has unit price elastic. Under free trade since price is given exogenously, the completeness of the market is not applicable any more, and income is not equal any more between the two states. If government provides the sector with a state contingent insurance, then the country will definitely be better off. When the country gains from trade while specializing incompletely, there may not be successful government intervention. Consider the example that $\theta_H = 2\theta_L$, $\theta_L = 2$, $\rho = 0.5$, $b = 0.5$, $\pi = 0.5$. In this case free trade is always better than autarky in the zone of incomplete specialization than autarky. Here if we try to introduce government intervention we will see that in the zone of incomplete specialization, free trade will be better. In figure 2 we plot the range of price for incomplete specialization given the aforesaid values of the parameters on the horizontal axis and the restricted trade utility to free trade utility ratio EV_{RT}/EV_{FT} on the vertical axis. It is clear that free trade will always be greater than restricted trade. However, if we have $\theta_H = 10\theta_L$, $\theta_L = 0.2$, the other parameters remaining unchanged, free trade will be better than autarky. Even then we can show that restricted trade will be better than free trade for a range of price within the zone of incomplete specialization. In figure 3 we plot the range of price for incomplete specialization given the changed values of the parameters on the horizontal axis and EV_{RT}/EV_{FT} on the vertical axis as before. Depending on the price free trade may or may not be better than restricted trade.

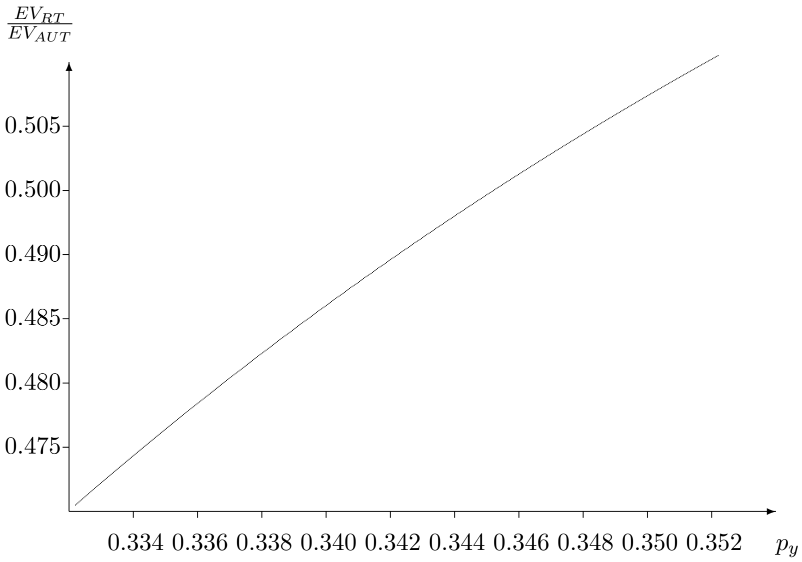

Figure 2: Diagram showing that free trade is better than restricted trade throughout the range of incomplete specialization

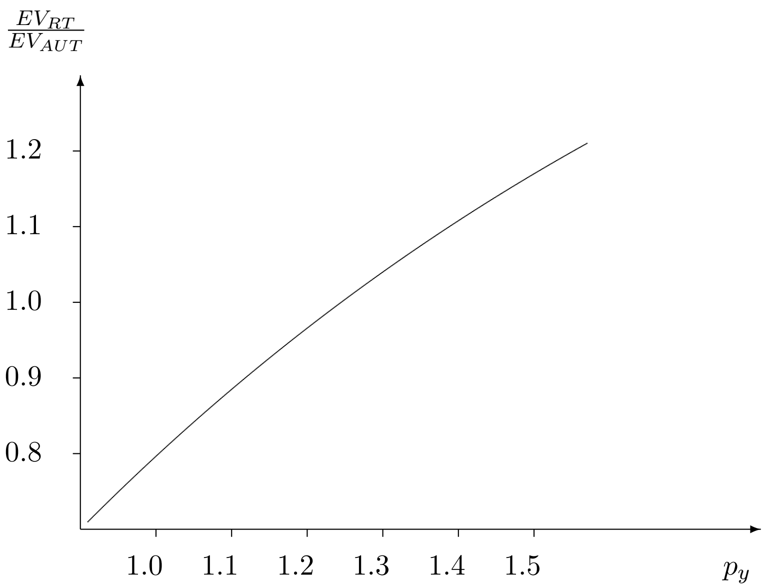

Figure 3: Diagram showing that in the initial range of incomplete specialization free trade is better, however in the later part of the range restricted trade is better than free trade

4 Two Country Framework

In Shy (1988) as well as in Newbery and Stiglitz (1981) trade takes place according to ex post comparative advantage. Countries are identical ex-ante. If both the countries have a good year or a bad year, then no trade can take place. We assume a two country world where both the countries are identical ex ante, having the same production and consumption structure as given in section 2. However, if one country has high output of y good, the other will have low output. Otherwise there cannot be any trade between the two countries. Therefore, the total output in the world market will remain constant in a free trade regime. This will make price independent of the state of nature. This suggests that the utility function under free trade will be given by equation (4). Because it is a two country framework and both the countries are identical ex ante, if one country completely specializes in one commodity, the other country will have the same incentive to specialize in that commodity. And hence (5) will be equated to 0 in order to maximize expected indirect utility w.r.t. labour allocation. Each individual will take the international price as given because of perfect competition, even though the country as a whole acts as a price maker.

$$\begin{aligned}\frac{\partial EV_{FT}}{\partial \alpha} &= p_y^{-b(1-\rho)}(\pi(\alpha + (1-\alpha)\theta_H p_y)^{-\rho}(1 - p_y\theta_H) \\ &+ (1-\pi)(\alpha + (1-\alpha)\theta_L p_y)^{-\rho}(1 - p_y\theta_L)) = 0 \end{aligned} \tag{22}$$

Rewriting equation (22)

$$\frac{\alpha + (1-\alpha)\theta_L p_y}{\alpha + (1-\alpha)\theta_H p_y} = A \tag{23}$$

$A = \left(\left(\frac{1-\pi}{\pi}\right)\left(\frac{1-p_y\theta_L}{p_y\theta_H - 1}\right)\right)^{1/\rho}$.

The world relative demand will be given by ap_y/b as before, However, the relative supply now will be $2\alpha/((1-\alpha)(\theta_H + \theta_L))$. From the world market clearing condition we get that

$$\frac{2\alpha}{(1-\alpha)(\theta_H + \theta_L)} = \frac{ap_y}{b} \tag{24}$$

Rewriting (22) we get back equation (23), which is nothing but our equation (6). Therefore, the optimal value of α denoted by α^* will be given by (7) in this case also. Now, from equation (24) we get

$$\alpha^{**} = \frac{1}{1 + \frac{2b}{ap_y(\theta_H + \theta_L)}} \tag{25}$$

For an equilibrium p_y to exist, α^* must be equal to α^{**}. In other words,

$$\frac{2b}{a(\theta_H + \theta_L)} = \frac{1 - A}{A\theta_H - \theta_L} \tag{26}$$

We know that $A = \left(\left(\frac{1-\pi}{\pi}\right)\left(\frac{1-p_y\theta_L}{p_y\theta_H-1}\right)\right)^{1/\rho}$. Therefore, LHS of equation (26) is a constant, while the RHS depends on p_y. $p_y \in (1/\theta_H, 1/\theta_L)$ since for p_y outside this range there will not be any interior solution of α. The countries are assumed to be identical ex ante, so the choice of factor allocation, which is done before the uncertainty is resolved, will be identical in both the countries. Therefore, $A < 1$. It is clear from the fact that $A < 1$ and equation (7) that an interior solution will be guaranteed when $A > \theta_L/\theta_H$. It can be shown that A is inversely related to p_y in the range of $1/\theta_H < p_y < 1/\theta_L$. This would mean that RHS is increasing in p_y. Therefore, if we plot RHS against p_y, we will get an upward rising function, while we will get a horizontal straight line if we plot LHS against p_y. This would guarantee the existence of a unique equilibrium. Now we have to see if this equilibrium gives a better utility. In Shy (1988) it was shown that for $\rho > 1$ free trade will definitely be worse than autarky. However, we will show taking numerical examples that even when $\rho > 1$, free trade might be better than autarky, and it might be worse than autarky also under a different set of condition when $\rho > 1$. Hence we can question the result in Shy (1988) and can say that since the assumption of indivisibility of labour is an additional source of inefficiency added to the production uncertainty, they got a strong result as that. In our numerical example we take $b = 0.5$, $\pi = 0.5$, $\theta_H = 2\theta_L$, $\theta_L = 0.2$ and $\rho = 5$. In such a situation, free trade will be worse off than autarky. However, if we change the value of ρ to 2 which is still greater than 1, the result will be reversed.

5 Conclusion

This paper tries to show that under autarky, the agricultural sector is naturally insured against the uncertainty in production. The reason is that when output decreases the price increases stabilizing somewhat the agricultural income. In this paper price increases by the same amount because of Cobb-Douglas utility function leaving agricultural income unchanged. It is seen that the outcome under autarky is Pareto optimal. When we consider a small open economy we see that with very high comparative advantage in either of the two sectors the gains from trade outweighs the loss due to uncertainty. When the country completely specializes in industrial good, it is better off under free trade, and the question of protection is rendered irrelevant. However, in case of incomplete specialization and complete specialization in the agricultural good with moderate comparative advantage, free trade may or may not be better than autarky. It has also been shown that in case of complete specialization in agriculture, whether or not free trade is better, restricted trade gives the best possible outcome. Under incomplete specialization when autarky is better than free trade, restricted trade is better than autarky, but it might not be better when free trade is better than autarky. When we extend the model to a two country framework, we do not see the result obtained in Shy (1988), where free trade is always inferior to autarky when degree of risk aversion is greater than unity. In this case also, the result is ambiguous. Advanced countries with strong comparative advantage in industrial goods where production is less uncertain, have no reason to restrict agricultural trade. Countries with strong comparative advantage for agricultural goods have reasons for government intervention which provides insurance. For all countries, some trade (free or restricted) in agriculture is always better than no trade.

References

[1] Batra, R. N. *The Pure Theory of International Trade under Uncertainty.* Macmillan, 1975.

[2] Batra, R. N., and Russell, W. R. Gains from Trade under Uncertainty. *American Economic Review 64*, 6 (December 1974), 1040–48.

[3] Eaton, J. The Allocation of Resources in an Open Economy with Uncertain Terms of Trade. *International Economic Review 20*, 2 (June 1979), 391–403.

[4] Eaton, J., and Grossman, G. M. Tariffs as Insurance: Optimal Commercial Policy when Domestic Markets are Incomplete. *Canadian Journal of Economics 18*, 2 (May 1985), 258–72.

[5] Grossman, G. M., and Razin, A. The Pattern of Trade in a Ricardian Model with Country-Specific Uncertainty. *International Economic Review 26*, 1 (February 1985), pp. 193–202.

[6] Helpman, E. Trade Patterns under Uncertainty with Country Specific Shocks. *Econometrica 56*, 3 (May 1988), pp. 645–659.

[7] Helpman, E., and Razin, A. *The Allocation of Resources in an Open Economy with Uncertain Terms of Trade.* Academic Press, 1978.

[8] Kemp, M. C., and Liviatan, N. Production and Trade Patterns under Uncertainty. *The Economic Record 49*, 126 (June 1973), 215–27.

[9] Mayer, W. Endogenous Tariff Formation. *American Economic Review 74*, 5 (December 1984), 970–985.

[10] Newbery, D. M. G., and Stiglitz, J. E. Pareto Inferior Trade. *The Review of Economic Studies 51*, 1 (January 1981), 1–12.

[11] Ruffin, R. J. International Trade under Uncertainty. *Journal of International Economics 4*, 3 (1974), 243–259.

[12] Shy, O. A General Equilibrium Model of Pareto Inferior Trade. *Journal of International Economics 51*, 1–2 (August 1988), 143–154.

[13] Swinnen, J. A Positive Theory of Agricultural Protection. *American Journal of Agricultural Economics 76*, 1 (February 1994), 1–14.

[14] Turnovsky, S. J. Technological and Price Uncertainty in a Ricardian Model of International Trade. *The Review of Economic Studies 41*, 2 (April 1974), 201–217.