UNITED NATIONS CONFERENCE ON TRADE AND DEVELOPMENT

Green Box Subsidies: A Theoretical and Empirical Assessment

UNITED NATIONS

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Executive Summary

The Uruguay Round Agreement on Agriculture (URAA) aimed at globally reducing trade distorting subsidies. However measures which were identified as having no or minimal trade distorting effects were to be categorized as Green Box (GB) measures. These measures were exempt from reduction commitments and subsidies under the GB could even be increased without any financial limitations under the WTO.

Recent research shows that current green box subsidies do not meet the criterion of 'no or at most minimal' trade distorting effects and that the so-called 'decoupled' programmes under Green Box do infact distort trade. The July 2004 framework provided a mandate for review and clarification of the Green Box criteria. At a broad level the negotiating proposals sought to (i) make the eligibility criteria for developed countries more restrictive and. (ii) clarify/ add additional criteria for covering programmes of developing countries that cause no or minimal trade-distortions. The justification for making the conditions more restrictive arises if Green Box subsidies do indeed distort production and trade.

While there is some theoretical justification for the trade distorting effects of Green Box, little empirical work has been undertaken to substantiate this claim. Using computable general equilibrium modelling, such as, the Global Trade Analysis Project (GTAP), and Data Envelopment Analysis (DEA), this paper presents empirical findings that help to shed some light onto the debate that Green Box subsidies do have significant distortive effects on trade and production. This study has diverted from an overall welfare approach (which is often criticised for not taking into account the distribution effects) to estimating the distributional effects especially on the poor. Recent studies on trade and poverty such as Cline (2004) suggest that reduction of inequalities depend on the pattern of trade liberalisation. This paper on GB shows that the pattern of trade liberalisation through the elimination of GB would be inequality reducing and the effects are likely to be different from tariff liberalisation.

The estimates of Green Box subsidies used here refer to the year 2000 or the nearest available data. Subsidies provided as food aid for food security purposes or those for government procurement or natural disaster relief have been removed from the calculations to arrive at an adjusted Green Box subsidy estimate. These subsidies provided largely for humanitarian

reasons or to address the food security of lower income groups, even if trade distorting, may need to be retained. Hence only the adjusted GB subsidy has been used in the computations in this paper.

DEA shows that the reduction of Green Box subsidies increases the cost of production in relative terms in countries such as Japan, Switzerland, EU and the US by about 15–30 per cent. Plugging these results into the GTAP model, significant trade and production effects are observed at a global level.

The paper shows that reduction of Green Box subsidies would leave global agricultural output virtually unchanged, registering a marginal increase of 0.13 per cent, seriously challenging the argument that reduction of subsidies would lead to a decline in global production. The largest decrease in output is seen in the EU, US, Canada, and Switzerland. The decline in output would be lowest in the United States perhaps because its Green Box subsidies are mostly directed to food aid. Conversely, most developing countries can expect to increase their agricultural output with reductions in Green Box subsidies, with Brazil, Chile, Thailand, Morocco, South Africa and Malaysia as frontrunners. Even the Least Developed countries (LDCs) would find their agricultural output increase by 3 per cent. These results demonstrate the viability of the redistribution of global output in favour of competitive agricultural producers especially developing countries consequent to the elimination of Green Box subsidies.

Further, the paper showcases how exports from developing countries and even the least developed countries can register an increase while overall global trade goes down on account of decline in exports of EU, US, Canada etc. Competitive developed countries such as Australia also stand to gain from removal of Green Box subsidies. United States, EU, and Canada would find their exports decline by about 40 per cent or more, whereas Switzerland and Japan would see their exports decline by over 60 per cent. Most developing countries would find that their exports register an increase of about 20 per cent. Even LDCs would find their exports go up by 20 per cent. Australia would see its exports go up by over 16 per cent.

As global imports decline, most countries would also show a lower dependence on agricultural imports. Switzerland, EU and Canada can be expected to register the highest declines of over 20 per cent. The changing pattern of international trade would also help to meet the

development objectives of the Doha Work Programme and in addition have positive livelihood effects. Agricultural employment would rise in almost all developing countries, while that in developed countries, especially those providing Green Box subsidies would fall. Wages would also rise by about 1 per cent on an average in developing countries with LDCs registering the highest increase. Further, the sum of the value (wage times quantity) of employment across all three sectors is positive in all developing and least developed countries. This implies that the poverty attenuating effects of the reduction of Green Box subsidies would be positive and significant.

To cross check the results the cost functions for five major crops in the United States has been estimated. A translog cost function using a panel data for the period 1975–2004 shows that if GB subsidies were to be removed cost of production would go up by 16 per cent. As far as specific components are concerned if general services and environment services were to be removed the cost of production would increase by 11 and 16 per cent respectively. If decoupled payments were to be removed the cost of production would increase by 4.6 per cent. The paper also shows that the cost of production of different crops would rise between 1 and 7% if GB subsidies were to be removed. Crops like wheat , corn and rice which are of maximum production and export interest to developing countries show the highest increase in cost when GB subsidies are removed. For all crops environmental subsidies are shown to be most sensitive to the cost of production.

To sum up, this paper provides preliminary evidence supporting the argument that Green Box subsidies are production and trade distorting. It indicates that effects of reduction of Green Box subsidies would be positive for developing countries including the LDCs. Further these effects would lead to poverty alleviation as it would impact the most vulnerable sections of society positively. It is therefore recommended that the current negotiations address the issue of eligibility of criteria of Green Box subsidies in developed countries on an urgent basis, with a view to restricting them.

INTRODUCTION

An important objective of the Uruguay Round Agreement on Agriculture is to reduce domestic measures of support that distort international trade and production in agriculture. But not all domestic support measures were deemed to be trade distorting and some of these measures considered to have no or minimal trade distorting effects were categorized as Green Box (GB) measures. Such measures were and are exempted from reduction commitments and can even be increased without any financial limitation under the WTO. Annex 2 of the Agreement on Agriculture sets out a number of general and measure-specific domestic support criteria which, when met, allow measures to be placed in the GB. These measures can be provided by both developed and developing countries. They must be provided through a publicly-funded government programme (including government revenue foregone) not involving transfers from consumers and must not have the effect of providing price support to producers.

However, recent research shows that in some instances current GB subsidies do not meet the criteria of 'no or minimal trade distortion'[1]. Studies have shown that the so-called 'decoupled' programmes under GB could distort trade. A large amount of money paid to farmers, decoupled with current production, nevertheless is likely to distort trade and production because of the wealth and risk effects associated with it. This problem is further compounded as these payments are not transitory measures, and are therefore permanently incorporated into the cash flows of farmers, thereby increasing their creditworthiness and serving as an instrument for hedging against risk. In addition, the practice of updating base acres, number of heads and payment yields, as well as changing eligible crops under Farm Assistance Programmes, tend to raise expectations of future assistance thereby influencing their future production decisions. Other important channels through which direct payments and insurance programmes can affect output are through their effects on capital and labour markets. Programmes that reduce income variability can increase farm investment by lowering the risk of loan default, thereby increasing rural credit availability. Investment aid takes different forms in different countries. In France and Germany it is used to a large extent to subsidize interest rates for farmers. French farmers, for instance, paid €274m less in interest in 2003 than they would have done without the assistance[2].

[1] Agreement on Agriculture, Annex 2, Paragraph 1
[2] Actionaid, Caritas Internationalis, CIDSE and Oxfam, (2005) 'Green but not Not Clean: Why a Comprehensive Review of Green Box Subsidies is Necessary', Joint NGO Briefing Paper, November 2005

It is in the context of this debate, the 2004 July framework provided a mandate for review and clarification of the GB criteria[3] to ensure that such measures have no, or minimal, trade and production distorting effects. Various negotiating proposals on reviewing GB subsidies have also been put forth by different members, including the G 20. On a broad level these proposals appear to be pursuing two objectives in the process of review and clarification of GB criteria: (i) making the eligibility criteria for developed countries more restrictive and (ii). clarifying/ adding additional criteria for covering programmes of developing countries that cause no or minimal trade-distortions; While there appears to be considerable degree of openness among Members to include changes to better tailor the GB criteria to meet the realities of developing country agriculture, there appears to be some resistance to altering the criteria for making them more restrictive.

Keeping in mind the debate and negotiating proposals on GB measures of support, this paper tries to empirically analyse whether GB subsidies have a distorting effect on production and international trade. This paper adopts a two fold empirical approach. The first approach is to estimate whether GB subsidies do have an impact on the cost efficiencies of countries, which in turn would have production and trade distortion effects. Using the DEA analysis, both parametric and non parametric, the impact of GB expenditures on agricultural productivity and cost efficiency is estimated. The results obtained are then plugged into the GTAP model so that the DEA results can be translated in terms of the impact GB expenditures might have on production and trade. Another test is carried out to analyse the differential impacts of GB subsidies on the cost of production of different crops. For this purpose initially a Cobb Douglas cost function is estimated for five major crops which constitute 81 per cent of total crop production in the US. This estimation would give the effect of total GB expenditures on cost of production of each crop. This is then followed by an estimation of the translog cost function for the same five crops in the same time period. The objective is to analyse the channels through which total GB and the different categories within GB such as general services, environmental services and decoupled payments affect the cost of production. .

[3] Paragraph 16 of the July 2004 framework specifies this mandate. http://www.wto.org/english/tratop_e/dda_e/draft_text_gc_dg_31july04_e.htm

The structure of the paper is as follows. Chapter I identifies the main criteria for providing GB support and also highlights the main theoretical debates around GB measures of support. Chapter II initially looks at trends in the changing proportion of expenditure among members across various GB categories. Given that the US, EU and Japan are the three countries that spend the maximum on GB expenditure this chapter also goes on to look at the structure of the domestic support in agriculture in these three countries both in terms of the different boxes—Amber, Blue and Green and also in terms of the different categories within GB. In Chapter III, an empirical analysis is presented to draw conclusions regarding the trade or production distorting effects of GB subsidies. This involves both DEA analysis and CGE modelling. Chapter IV is an illustration of the general effects of GB subsidies on specific crops using US data. While the translog cost estimate analyses the impact of total GB and the different categories of GB on the cost of production, the Cobb Douglas cost estimate looks at the differential impact of GB on different crops. Chapter V looks at the mandate for review and clarification of the GB criteria and also dwells briefly on the WTO negotiations in this area. Chapter VI puts forth the conclusions of the paper.

I. THEORETICAL DEBATES AROUND GB MEASURES

This chapter first specifies the criteria for GB subsidies as mentioned in Annex 2 of the Agreement on Agriculture. It examines the theoretical debates around GB subsidies in literature particularly the various ways in which such subsidies might have a distorting effect on trade and production.

Criteria for GB Subsidies[4]

Apart from being 'no or minimally trade and production distorting' these support measures should be provided through a publicly funded government programme (including government revenue foregone) not involving transfers from consumers and must not have the effect of providing price support to producers. The two broad categories of GB subsidies are Government service programmes and Direct Payments to producers.

Government service programmes

The GB covers many government service programmes including general services provided by governments, public stockholding programmes for food security purposes and domestic food aid—as long as the general criteria and some other measure-specific criteria are met by each measure concerned. The GB thus provides for the continuation (and enhancement) of programmes such as:

- Research, including general research, research in connection with environmental programmes, and research programmes relating to particular products;
- Pest and Disease Control Programmes, including general and product-specific pest and disease control measures;
- Agricultural training services and extension and advisory services;
- Inspection Services, including general inspection services and the inspection of particular products for health, safety, grading or standardization purposes; marketing and promotion services;
- Infrastructural services, including electricity reticulation, roads and other means of transport, market and port facilities, water supply facilities, etc;
- Expenditures in relation to the accumulation and holding of public stocks for food security purposes; and

[4] This section is based on the information extracted from the WTO website *www.wto.org*

- Expenditures in relation to the provision of domestic food aid to sections of the population in need.

Many of the regular programmes of governments are thus given the 'green light' to continue.

Direct payments to producers

The GB also provides for direct payments to producers (that is, farmers) which are not linked to production decisions, the type or volume of agricultural production (this is termed as 'decoupling'). This precludes any linkage between the amount of such payment, on the one hand, and production, prices or factors of production in any year **after** a fixed base period. In addition, no production is required in order to receive such payments. Additional criteria to be met depend on the type of measure concerned which may include:

- Decoupled income support measures;
- Income insurance and safety-net programmes;
- Natural disaster relief;
- Structural adjustment assistance programmes; and
- Certain payments under environmental programmes and regional assistance programmes.

Theoretical debates on GB Measures

Recent research identifies various ways through which GB subsidies can affect agricultural trade and production through wealth and risk effects, cost effects, insurance effects, expectation effects and productivity increases. We discuss some of these effects below.

Wealth and risk effects

Direct payments, used for decoupled income support, are exempt from reduction commitments, in the WTO Agreement on Agriculture since they are supposed to be lump sum transfers with no effect on production decisions. Further since direct payments are based on a past, fixed base period, farmers cannot affect payment size through current behaviour.Therefore their current production decisions could only be based on market considerations[5]. This is the rationale

[5] A similar idea is that support will be mostly decoupled when the quantity of production receiving support is substantially less then the total quantity produced at world prices. This method of support is often termed a 'Producer Entitlement Guarantee Scheme' (Blandford, de Gorter, and Harvey 1988). This approach does not require support to be based on a fixed historic benchmark. The programme can be thought of as supply management for government support where support is tied to levels of production well below the level of production at world prices. Producers could trade their entitlements to government support.

behind compensation programmes such as the 'production flexibility contract payments' under the United States Federal Agriculture Improvement and Reform Act and Canada's WGTPP (Western Gains Transition Payment Programme) which compensated for the discontinuation of the subsidies under the WGTA (Western Grains Transportation Act).

The mere fact that a decoupled support is not linked to the current volume of production however does not make it non-trade distortive. Income support may have the tendency to influence production decisions in a manner that could be inconsistent with the principles of free market and fair competition. Recent estimates suggest that 'decoupled' payments do have a positive impact on output, given their role on reducing risk[6]. It has been argued that the effect of a fixed direct payment on production is strongly determined by the risk behaviour of the producer. For a risk-averse producer, the direct payment can produce a wealth effect. Sandmo (1971), Pope and Just (1991), and Hennessy (1998) demonstrate how the increase in wealth created by a direct payment might increase the farmer's capacity to take risk or expand production by planting crops that would otherwise be viewed to be too risky. Pope and Just (1991) show that policies that affect initial wealth, impact profits both directly and indirectly—the problem is accentuated when decoupled payments are provided in conjunction with Amber Box or Blue Box subsidies.

Consider a simple optimization problem for a representative producer who maximizes profits.

$$Max_Q \Pi = P_T.Q_T - C(Q_T) + S.(Q_B)$$

Where Π is the profit earned by the producer

$P_T.Q_T$ is the total revenue at time T

C (Q) is the total cost

S (Q_B) is a unit subsidy based on past production for a base period

The producer's profits are calculated as the difference between revenues (P.Q) and total costs C (Q) plus a unit subsidy, S.

Profits are maximized when production is allocated such that marginal revenue (MR) is equated to marginal cost (MC).

MR–MC = $P - \partial C / \partial Q = 0$

[6] Bouët et al 2003

Because the subsidy, S, depends on past production (Q_B) it does not enter into the marginal decision. In fact any subsidy which does not directly affect the optimality condition, that marginal revenue equals marginal cost, will be neutral, in the sense that it does not encourage changes in production.

However, the property of the producer's optimization problem, shown above, which accommodated the neutrality of a fixed direct payment does not hold for more sophisticated optimization models which account for risk preferences. For, instance, if the producer is risk averse he/she maximizes expected utility (EU) from profits:

$$Max_Q EU(\Pi) = E[U\{P_T.Q_T - C(Q_T) + S.(Q_B)\}]$$

$$\text{MR–MC} = E[U'(\Pi)(P - \partial C / \partial Q)] = 0$$

This sophisticated model takes into account expectations and a first order derivation of this term, contrary to the earlier derivation, retains the subsidy term. Since the subsidy term is not eliminated from the producer's optimization problem it affects production. This clearly shows how GB subsidies might impact production through the risk effects.

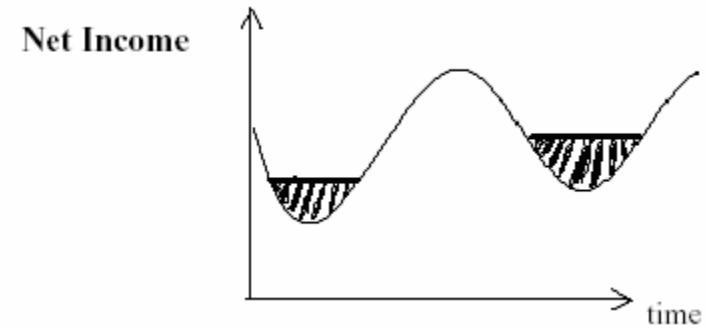
A study of US acreage responses by Chavas and Holt (1990) incorporated wealth into the model and found that both wealth and risk perceptions were important determinants of acreage allocation decisions for corn and soybeans. It also revealed that under some conditions, the wealth effect was even more important than the direct price effect on acreage planted. In a more recent study Roe, Somwaru, and Diao (2004) used a CGE model to test the intertemporal effects of direct payments on US agriculture. They ran two simulations, one assuming integrated capital markets and the other assuming segmented capital markets[7]. They found that Production Flexibility Contract payments had effects on land value in both simulations. The PFC payments increased land values which in turn could lead to increased production due to increased access to credit. This finding that direct payments might lead to increased production is supported by a number of studies on PFC payments (Burfisher and Hopkins 2003; Roberts, Kirwan and Hopkins 2003).

[7] Integrated Capital Markets are those where the agricultural capital markets are integrated with capital markets in the rest of the economy at each point in time.

Insurance effects

GB subsidies such as government provided safety nets can act as insurance and affect production in a way demonstrated below in Figure 1. A safety net is a technique used for stabilizing variables such as farm income by assuring a minimum income level which acts as a floor (truncating the trough of an income cycle). When safety nets exist expected net income might create an incentive to increase production[8] as shown in Figure 1. Farmers who are protected by insurance from downward income fluctuations have more risk taking capacity in agricultural production related decisions as they are aware of their floor level of income in case of an eventuality. Further the level of the floor also affects the levels of production as is depicted in the figure. For instance from the figure it can be seen that higher the level of the ceiling more is the amplitude of the trough which might indicate higher levels of production.

Figure 1 The Insurance Effects of Safety Nets



Empirical evidence of the effect of insurance on input use is mixed. Horowitz and Lichtenberg (1993) and Knight and Coble (1997) conclude that crop insurance increases the use of fertilizer and pesticides. Smith and Goodwin (1996) conclude that fertilizer expenditures will decrease with crop insurance. Agriculture Canada Report (1994) however concludes that for Canada, cropping decisions are based on a number of broad factors including market conditions and other programmes which overwhelm the effects of crop insurance.

Crop insurance might create an incentive for risk-averse producers to increase output by using more inputs even in the face of probable low yield. On the other hand if inputs are risk-reducing inputs, such as pesticides in general, then the insured person's optimal decision could

[8] Domestic Support: Green Box Measures and Other Exempt Support, http://www.umanitoba.ca/afs/agric_economics/course/065.303/notes/Oct16.pdf#search=%22Domestic%20Support%3A%20Green%20Box%20Measures%20and%20Other%20Exempt%20Support%22
http://www.ers.usda.gov/briefing/FarmPolicy/gov-pay.htm

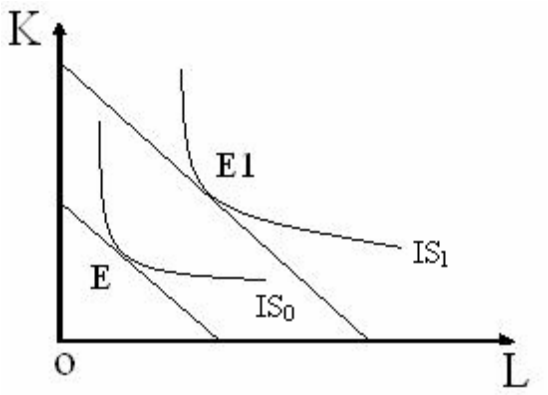
change as a result of being insured and the producer could be inclined to use less of the input. In other words, because the insurance contract reduces the loss associated with the insured event, the producer might be willing to take a more risky decision. This is termed as 'moral hazard in crop insurance' and theoretical models in this area support the conclusion that the direction of the moral hazard effect on input use, output, and expected indemnities is ambiguous unless strong assumptions are made about risk preferences and input risk properties.

Crop insurance also may encourage producers to move risky marginal land into production and the crop mix may be biased towards production of more risky crops. Agricultural incomes being subject to instabilities and fluctuations, risk-averse farmers may benefit considerably from income stabilization measures such as countercyclical subsidies. These income-stabilization programmes and fixed payments may have a risk-reducing effect.

Cost, price and expectation effects

There are situations where the direct payment can indirectly affect the decisions of risk neutral producers as well. Such payments help producers to overcome their credit constraints. Consider a producer who faces a constrained optimization problem. A direct payment may reduce the constraints limiting this farmer's production potential and as a consequence leading him to increase production. Theory suggests that greater the resources available at farmer's disposal (Cost outlay) further the isocost line will be from the origin (since more of both labour (L) and capital (K) can be purchased provided their prices remain the same). This argument can be even extended to farmers facing no resource constraints as additional resources obtained through direct payments might be used for purchasing additional inputs. Figure 2 demonstrates how the producer's equilibrium shifts from the first isoquant IS_0 to another isoquant IS_1 at a higher level of output because the isocost line shifts upward with expanded resources due to decoupled support (assuming factor prices remain constant).

Figure 2 Shift in Producer's Equilibrium.



There are other potential effects on production such as increases in production executed in anticipation that the higher level of production now will form the new base for a new programme (expectation effect). For instance the 2002 Farm Security and Rural Investment Act in the US allowed farmers to update their base acres from the 1981-85 planting history used in the FAIR Act(1996) to a more recent production. Even if the subsidy does not affect marginal production decisions, it can affect the decisions to exit or enter.[9]

There are a number of examples cited by Rude (1998) on how production might be affected by GB payments, the first of which is placed in an increasing returns to scale scenario. Increasing returns imply that at each level of output, marginal cost is less then average cost. In this case a fixed direct payment would increase average revenue, lowering average cost and increasing level of production. The second instance where payments based on past performance could affect current decisions is in the context of behavioural theories of the firm. Instead of assuming profit maximizing behaviour by the firms these theories assume 'satisficing' behaviour. Under satisficing behaviour theory, the interaction of goals through the bargaining and coalition making process of the organization is assumed to determine resource allocation. This allocation within the firm reflects only gross comparisons of the marginal advantages of alternatives. Any alternative that satisfies the constraints and secures suitably powerful support within the organization is likely to be adopted (Cyert and March;1963). In this context direct payments loosen constraints and encourage continuation of the status quo, possibly increasing production.

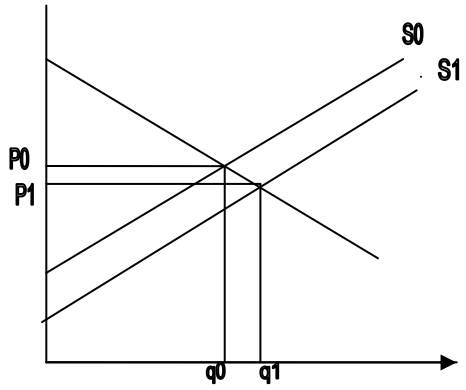
[9] 'Domestic Support: Green Box Measures and Other Exempt Support' http://www.ers.usda.gov/briefing/FarmPolicy/gov-pay.htm

The third instance cites situations where the producer faces debt constraints. The payment which was neutral in the non-debt constrained case leads to increased future production in the debt constrained case (Phimister 1995). Furthermore, Roberts (1997) argues that given a farmer's specialized skills, and the absence of perfect capital and information markets, significant amounts of the fixed direct payments are likely to be invested in the farm even if there are no debt constraints. There may be more examples of situations in which a direct payment would relax a production constraint and consequently lead to increased production.

Productivity Effects

GB measures could also have a distorting effect on production through increasing productivity. For instance measures such as research and extension services, conservation, environmental and natural resource programmes, structural programmes to adjust farm size and numbers, infrastructure under GB may have production effects on long-term agricultural production. These programmes cause productivity improvements which shift the supply curve as shown in Figure 3 increasing output from q_0 to q_1. If the GB provider is not a small country then, world prices of agriculture products can decline with possible augmentation of global production. Figure 3 showcases the mechanism by which world prices go down from P0 to P1 due to the provision of GB subsidies, assuming demand remains constant.

Figure 3 Productivity Improvement & Shift in Supply Curve.



GB measures such as environmental programmes might also have impacts on productivity though this would depend on the nature of the programme and also on the technical relation between agricultural and environmental factors (Diakosavvas; 2003).

Conclusion

The criteria specified in Annex 2 on classifying GB subsidies try to ensure they are decoupled from production and hence have no or minimal trade and production distorting effects. But a review of the literature shows that this may not necessarily be correct as they may influence the risk behaviour of the producer, have an impact on productivity increases or reduce the cost of production. These issues have been analysed empirically in the subsequent chapters.

II. ANALYSIS OF GB MEASURES OF THE UNITED STATES, EUROPEAN UNION AND JAPAN

As a result of the URAA mandate to reduce trade distorting subsidies it has been argued that many WTO members have gradually shifted their agricultural support to GB categories through a readjustment of their domestic policies (Hart and Babcock, 2002). Among the WTO members the highest level of GB expenditure is by three countries- the US, EU and Japan[10]. In 2001 the US expenditure on GB policies was $ 50,672 million. This was the highest expenditure on GB by a member state of the WTO. The GB expenditure by Japan and EU were also quite high in this period at levels of $ 21,050 million and $ 23,316 million respectively[11]. This is in stark contrast to the low levels of GB expenditure by most developing countries. In this context, an understanding of the structure of domestic support in US, EU and Japan is essential for any meaningful analysis of the distorting efforts of GB on production and trade. Hence this chapter examines the structure of domestic support in these three countries both in terms of the different boxes such as Amber, Blue and Green and also in terms of the various categories within GB. The objectives of this exercise are threefold. These are to examine whether in the context of the farm acts enacted in these countries over the past years: (1) there has been a shift of subsidies between the different boxes among these countries (2) there has been an increase in GB expenditure in these countries and (3) there has been a greater increase in some components of GB subsidies compared to others.

Overall Structure of Domestic Support for the US, EU and Japan

Table 1 gives the composition of domestic support for the US, EU and Japan across Green Box, Blue Box and Amber Box. It can be seen that in the US, GB accounted for 74.68 per cent of the total support spending in 1999. It remained relatively unchanged for 2000, but increased to 77.85 per cent in 2001 , while amber box expenditure reduced to 22.14 per cent from 25.13 per cent in 2000. GB expenditure in the EU rose from 20 per cent of overall domestic support in 1995 to about 25 per cent in 2001, while during the same period Amber Box expenditure reduced from 52 per cent of overall support in 1999 to 47 per cent in 2001. Thus it can be seen that the pattern of GB support in the EU is similar to that of the US. Japan also shows an increase in GB expenditure from 47 per cent in 1995 to 77 per cent in 2001 and Amber Box expenditure reducing from 21 per cent in 1999 to 20 per cent in 2001. Comparing across the

[10] This can be inferred from table 12 in chapter 3 which provides the average GB expenditure for the three countries over the period 1995-2000.
[11] WTO notifications of EC, US and Japan concerning domestic support commitments.

three WTO members, it can be seen that US and Japan have much higher shares of GB support as a share of their overall domestic support. But all the three members show similar trends in terms of reduction of amber box spending and increase in their share of GB spending over the years 1999–2001.In absolute levels the increase in GB might not be very large or might have even showed small declines. But the fact to be noted is that while the other categories of domestic support such as Blue box and Amber box have declined, there has been no such proportional decline in GB. This might indicate the probability of box shifting.

Table 1 Structure of Domestic Support for the US, EU and Japan (in Domestic Currencies).

United States (Million US Dollars)										
	1995		1998		1999		2000		2001	
	amount	% of Total Domestic Support	amount	% of Total Domestic Support	amount	% of Total Domestic Support	amount	% of Total Domestic Support	amount	% D S
Green box	46,033	88	49,824	83%	49,794	74%	50,057	74%	50,672	7
Blue box	0		0	0	0	0	0	0	0	
Total AMS	6,213	12	10,391	17%	16,862.2	25	16,802.58	25	14,413.05	2
others	0		0	0	0	0	0	0	0	0
Total	52,246		60,215	100	66,611	100	66,860	100	65,085	1
European Union (Million Euro)										
	1995		1998		1999		2000		2001	
		% of Total Domestic Support	Amount	% of Total Domestic Support	amount	% of Total Domestic Support	Amount	% of Total Domestic Support	Amount	% D S
Green Box	18,718.00	20%	19,168	22%	19,930.50	23%	21,844.50	25%	20,661.20	
Total AMS	47,526.40	52%	46,683	54%	47,885.70	55%	43,654	50%	39,281.30	
Blue Box	25412.3061	28%	20503.5	24%	19,792.10	23%	22,222.70	25%	23,725.90	
Total	91,656.71		86,355		87,608.30		87,721.20		83,668.40	
Japan (Billion Yen)										
	1995		1998		1999		2000		2001	
		% of Total Domestic Support	Amount	% of Total Domestic Support	Amount	% of Total Domestic Support	Amount	% of Total Domestic Support	Amount	D S
Green Box	3169	47%	3001.6	79%	2685.9	76%	2595.3	76%	2546.9	
Blue Box	3,507.50	53%	766.5	20%	747.8	21%	708.5	21%	666.7	
Total AMS	0	0%	50.2	1%	92.7	3%	92.7	3%	91.1	
Total	6,676.50		3818.3		3526.4		3396.5		3304.7	

Source- WTO Notifications

Box 1 Box Shifting.

The pattern of domestic support in the US, EU and Japan has changed significantly over the past few years, with the proportion of GB component increasing in the total domestic support, commonly referred to as box shifting.

The US has increased its GB spending by a large amount over the past several years. Over the period 1986–88, programmes that would have qualified for the GB had total expenditures of, on average, just over $26 billion. From 1996 to 1998, GB spending had increased to an average of $50 billion(Hart and Babcock ,2002). Because the GB spending is exempt from WTO limits, the US can continue to add to this total. In the EU and Japan, the phenomenon is more recent: from 1995 onwards, Amber and Blue Box expenditures have reduced, while GB spending has increased or remained at similar levels. In the EU, GB as a percentage of total domestic support has increased from 21 per cent in 1995 to 25 per cent in 2001. In Japan, the GB percentage increased from 46 per cent in 1995 to 78 per cent in 2000. It has been estimated that as a result of the CAP 2003 reforms, the EU would be in a position to shift about 75 per cent of its subsidies from the Blue Box to the GB (Agra Europe ,2003). Further, the GB subsidies might remain partially coupled to the present or future production, leading to distortions in production. The partial coupling could occur because of two factors.

(1) The fact that the US and EU Acts have not defined an unchanging base period could lead to expectation effects that might lead to an increase in production (2) Further exclusion of direct payments to certain crops such as fruits and vegetables under both the Production Flexibility Contracts (PFCs) in the US and also under the CAP reforms in the EU could lead to a distortion in the production structure. Supporting these theoretical arguments, certain assessments conducted for the EU find that decoupled payments would increase the production of most of the cereals in 2009 compared to 2002. To conclude, the likely shift in certain developed countries towards providing support through the GB would be a cause of concern; particularly because the decoupling is only partial and even decoupled subsidies can be production and trade distorting(Agra Europe ,2003).

Box 2 Farm Reforms in the United States.

Fair Act (Federal Agricultural Improvement & Reform Act) 1996 introduced production flexibility contracts or PFCs which ran from 1996 to 2002. These payments were based on past production and were independent of current market prices and farmers' planting decisions. These fixed payments replaced the earlier deficiency payments but did not require continued production of the crop for which payments were received. A mechanism was also put in place for many crops that allowed farmers to receive a cash payment—a 'marketing gain' or 'loan deficiency payment' (LDP) — if market prices were below their loan rate levels.

Farm Act 2002 replaced PFCs by a very similar scheme of direct payments which were extended to cover more crops such as soybeans, other oilseeds, and peanuts. Fixed direct payments are not tied to production of specific crops, the amount of production, or the price of the crop. This bill also introduced counter cyclical support payments. This program was developed to provide an improved counter-cyclical income safety net to replace most ad hoc market loss assistance payments that were provided to farmers during 1998-2001. Payments are based on historical production and are not tied to current production. This bill also retained the marketing assistance provisions from 1996 and extended it further to peanuts, wool, mohair, and honey. To support dairy farmers a new market loss payments programme was developed to provide a price safety net and to replace ad hoc market loss assistance payments that were provided to milk producers in 1999, 2000, and 2001.

It has been argued that the PFCs provided under the Act of 1996 and the direct payments under the Act of 2002 are not totally decoupled and might have production distortion effects. Given the limited data availability, production estimates are difficult to make. However, evidence from the US on PFCs suggests that these subsidies have increased the total planted acreage. The Economic Research Service (ERS) predicts that under the PFCs the area of total plantings increased by between 225,000 to 725,000 acres. Further under the 1996 Farm Act the PFC payment scheme excluded fruits and vegetables. The provisions

under the payment scheme which replaced the 2002 Farm Act are the same except for the fact that wild rice would also be treated the same as a fruit/vegetable. This exclusion is criticized for its distorting effect on the production decisions of producers in the US. The Acts have also been criticized on the basis that not defining an unchanging base period might create expectation effects among producers that would lead to an increase in the production.

Category wise Expenditure on GB by the US, EU and Japan

This section examines the spending of US, EU and Japan under the different GB categories—General Services, Public Stockholding for Food Security Purposes, Domestic Food Aid, Decoupled Income Support, Income Insurance and Income Safety Net Programmes, Payments for Relief From Natural Disaster, Structural Adjustment through Producer/Resource Retirement Aids, Structural Adjustment through Investment Aids, Environmental Programme Payments, Regional Assistance Programmes.

General Services

GB policies on general services involve expenditures in relation to programmes which provide services or benefits to agriculture or the rural community. They do not include direct payments to producers or processors. General services apart from meeting the general criteria also include categories such as general research, pest and disease control, training services, extension and advisory services, inspection services, marketing and promotion services and infrastructural services.

Table 2 Expenditure on General Services in the US, EU and Japan (in US $ million).

GENERAL SERVICES								
	1998		1999		2000		2001	
	Amount	%	Amount		Amount	%	Amount	%
United States	7,146	14	7,694	15	8,554	17	9,214	18
EU	5,587.12	26.18	5,621.99	24.08	4,370.18	21.71	5,043.75	27.28
Japan	19,817.42	86.43	20,264.78	85.94	20,096.51	86.43	17,234.57	82.24

Note: Percentage figures are with reference to overall GB Support.
Source: WTO Notifications. Currency conversions have been calculated using the Wikipedia table of Historical Exchange Rates

Table 2 provides the break up of the GB expenditure in US, EU and Japan under the general services category. It can be seen that Japan has the highest percentage of GB expenditure under this head though it has decreased slightly from 86 per cent of total GB expenditure in 1998 to

82.24 per cent of GB expenditure in 2001. EU's expenditure under this head has been stable over the period 1998–2001 at around 26 per cent. The US expenditure in General services category has been much lower compared to EU and Japan and constitutes only 18 per cent of overall GB support in 2001, though there has been a slight increase from 14 per cent in 1998 to 18 per cent in 2001. Theoretically expenditure on general services is argued to distort trade and production by increasing productivity of agricultural production. For instance as depicted in Figure 3 (Chapter 1) GB expenditure under general services might shift the agricultural products supply curve with an increase in productivity. This theoretical argument is also supported by our empirical analysis. For instance our DEA analysis in the next chapter shows that Japan experiences the highest Total Factor Productivity increase as a result of GB expenditure. The reason for this may lie in the fact that majority of Japan's GB expenditure is in the form of General Services.

Public Stockholding for Food Security Purposes

GB support in this category includes expenditure towards the accumulation and holding of stocks of products which form an integral part of a food security programme identified in national legislation. The volume and accumulation of such stocks correspond to predetermined targets related solely to food security.

Table 3 Expenditure on Public Stockholding for Food Security Purposes in the US, EU and Japan (in US $ million)

Public Stockholding for Food Security Purposes								
	1998		1999		2000		2001	
	Amount	%	Amount		Amount	%	Amount	%
United States	0	0	0	0	0	0	0	0
EU	21.26	0.100	21.30	0.091	17.87	0.089	16.19	0.088
Japan	432.37	1.89	410.86	1.74	430.57	1.85	356.29	1.70

Note: Percentage figures are with reference to overall GB Support
Source: WTO Notifications. Currency conversions have been calculated using the Wikipedia Table of Historical Exchange Rates

Table 3 provides the GB expenditure of US, EU and Japan under the public stockholding for food security purposes category. It can be seen that US does not have any spending under this category. Japan has been spending around 1.9 per cent of its overall GB on public

stockholding. The EU has been spending even less and from 1998 to 2001 the overall spending by EU on this category has fallen from 1 per cent to .088 per cent of total GB expenditure.

Domestic Food Aid

Domestic food aid under GB involves expenditures on food aid to sections of the domestic population in need. Clearly defined criteria related to nutritional objectives determine the eligibility to receive food aid. Though food aid might not have any directly distorting effects on the cost of production it might have minor impacts on production. In fact a 2002 ERS report[12] using CGE modelling found that cuts in the US food programme could marginally decrease farm and food processing production.

Table 4 Expenditure on Domestic Food Aid in the US, EU and Japan (in US $ million)

Domestic Food Aid								
	1998		1999		2000		2001	
	Amount	per cent	Amount		Amount	per cent	Amount	per cent
United States	33,487	67	33,050	66	32,377	65	33,916	67
EU	306.98	1.44	295.97	1.27	248.94	1.24	217.27	1.18
Japan	105.42	0.46	81.65	0.34	50	0.21	4	0.20

Note: Percentage figures are with reference to overall GB Support.
Source: WTO Notifications Currency conversions have been calculated using the Wikipedia Table of Historical Exchange Rates

The above table depicts the expenditure of US, EU and Japan on domestic food aid. US spends the largest proportion of its overall GB expenditure on domestic food aid. EU and Japan spend a very small percentage of their overall GB expenditure on this category with that of EU declining from 1.44 per cent in 98 to 1.18 per cent in 2001 and that of Japan declining from 0.46 per cent to 0.20 per cent in 2001.

Decoupled Income Support

Direct payments to producers are considered decoupled payments if they are not related to or based on market prices (domestic and international), the type or volume of production, or factors of production in any year after a defined and fixed base period. Decoupled income

[12] Tracing the Impacts of Food Assistance Programs on Agriculture and Consumers: A Computable General Equilibrium Model http://www.ers.usda.gov/Publications/fanrr18/

support arguably reduces the cost of production as depicted in figure 2 displayed earlier. This would have distortive effects on production and trade . Such payments might also have a wealth effect, and hence significant effects on acreage decisions of different crops. Decoupled payments can cover fixed and variable production costs, help overcome capital constraints by influencing supply of loans to producers, affect expectations, and retain producers in agriculture where exiting would be the rational decision(Abler and Blandford ,2005).

Table 5 Expenditure on Decoupled Income Support in US, EU and Japan (in US$ million).

Decoupled Income Support								
	1998		1999		2000		2001	
	Amount	per cent	Amount		Amount	per cent	Amount	Per cent
US	**5,659**	**11**	**5,471**	**11**	**5,068**	**10**	**4,100**	**8**
EU	143.19	0.67	1020.14	4.37	454.49	2.26	148.46	0.80
Japan	0	0	0	0	0	0	0	0

Note: Percentage figures are with reference to overall GB Support
Source: WTO Notifications. Currency conversions have been calculated using the Wikipedia Table of Historical Exchange Rates

On comparing decoupled income support in EU, US and Japan it can be seen that the decoupled support provided by the US has fallen over the years from 11 per cent of overall GB expenditure to 8 per cent. In the EU decoupled income support increased from 98 to 99 from 0.67 per cent of overall GB to 4.37 per cent but thereafter decreased to 0.80 per cent in 2001. Japan did not notify any decoupled income support during this period. Though there has been a decline in decoupled income support within the US, it still has the highest expenditure on this category among these three countries. Under the 2002 Farm Bill decoupled direct payments are the highest for wheat and corn ($ 0.52 and $ 0.28 per bushel)[13] after rice and peanuts. This might be the reason why our subsequent empirical analysis of the Cobb Douglas Cost function shows the maximum impact of decoupled payments on wheat and corn.

Box 3 Farm Reforms in the European Union.

Common Agricultural Policy (CAP) Reforms
1993–5 CAP Reforms introduced direct payments and strengthened environmental efforts.
2000 CAP Reforms The stated objective of these reforms was to decrease government interventions, price and subsidy support while increasing compensation and direct income support payments. This reform also allowed Member countries to offer direct payments to environmental programmes and provided financial support to environment-friendly activities such as organic farming and protecting semi-natural residential areas, wetlands and traditional orchards.
2003 CAP Reforms The main feature of this reform was the introduction of a single payment scheme for

[13] http://www.farmfoundation.org/projects/documents/Westcott_000.pdf

the EU farmers, decoupled from production with limited 'coupled' elements where member states consider this necessary to avoid abandonment of production, and the requirement for cross compliance which entails that the single payment be linked with environmental, food safety, animal and plant health and animal welfare standards, as well as to the requirement to keep all farmland in good agricultural and environmental condition.

This act has been criticized on the basis that the decoupled payments might have impacts on production. Further the EU proposals on decoupling are even more flexible than the US proposals since they do not require land to be under production but in good 'agricultural condition'. More importantly, there is a possibility of changing the base period in future which might lead to expectation effects among the producers which would in turn lead to increased agricultural production. Further the single payment scheme under the CAP reforms of 2003 may be used for any agricultural activity except for fruit, vegetables and table potatoes. This exclusion might as in the case of US PFCs lead to distortions in production. In fact certain assessments conducted for the EU find that decoupled payments would increase the production of most of the cereals in 2009 compared to 2002.

Income Insurance and Income Safety Net Programmes

Direct payments to producers are considered to be income insurance and safety net payments if they meet four policy specific criteria:

- eligible producers have experienced a loss that exceeds 30 per cent of average gross income, or the equivalent in the preceding 3–5 years;
- the amount of such payments compensates less than 70 per cent of the eligible producer's income loss in the year,
- payments relate solely to income and not to prices, production or factor use; and
- payments from this provision combined with that for natural disaster total to less than 100 per cent of the total loss for individual farmers.

Both US and Japan have not notified any expenditure under this head during 1998–2001. The EU has notified during the years 2000 and 2001, $ 4.61 and $ 9.57 million respectively.

Table 6 Expenditure on Income Insurance and Income Safety Net Programmes in the US, EU and Japan (In US million Dollars)

Income Insurance and Income Safety Net Programmes								
	1998		1999		2000		2001	
	Amount	per cent	Amount		Amount	per cent	Amount	per cent
United States	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
EU	0	0	**0**	**0**	4.61	0.02	9.57	0.05
Japan	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**

Note- Percentage figures are with reference to overall Green Box Support
Source- WTO Notifications
Currency conversions have been calculated using the Wikipedia table of Historical Exchange Rates

Both US and Japan have not notified any expenditure under this head during 1998-2001. The EU has notified during the years 2000 and 2001 4.61 and 9.57 million US dollars respectively.

Payments under income insurance and safety net programmes theoretically can be argued to have a production and trade distorting effect as is depicted by Figure 1 in Chapter 1.

Payments for Relief from Natural Disaster

In terms of distortions in costs of production natural disaster payments might have two conflicting effects: on the one hand they could help producers cover costs which they would otherwise incur themselves and on the other hand they might also raise moral hazard issues that would induce farmers to produce in risky environments. But natural disaster payments also have an economic justification since they help ameliorate market failures.

Table 7 Expenditure on Payments for Relief from Natural Disaster in US, EU and Japan (in US$ million).

	Payments for Relief From Natural Disaster							
	1998		1999		2000		2001	
	Amount	per cent	Amount		Amount	per cent	Amount	per cent
US	1,411	3	1,635	3	2,141	4	1,421	3
EU	203.32	0.95	389.41	1.67	359.87	1.79	356.87	1.93
Japan	447.65	1.95	508.31	2.16	515.01	2.21	445.16	2.12

Note: Percentage figures are with reference to overall GB Support
Source: WTO Notifications. Currency conversions have been calculated using the Wikipedia Table of Historical Exchange Rates

Over the period 1995–2001 the US has been spending 3 per cent of its overall GB expenditure on this category of support. The US expenditure on this head has been higher than both the EU and Japanese expenditure. However, it must be noted that the EU and Japanese expenditure on this category has increased from 1998 to 2001.

Structural Adjustment through Producer/Resource Retirement Aids

The US expenditure on this category has remained stable over the period 1998–2001 at 3 per cent of overall US expenditure on GB. The percentage of expenditure on structural adjustment on producer/retirement aids as a percentage of overall GB has declined for the EU from 5.93

per cent in 1998 to 4.33 per cent in 2001. As per Japan's notification the expenditure on this head has increased slightly from 2.8 per cent in 1998 to 3.85 per cent in 2001.

Table 8 Expenditure on Structural Adjustment through Producer/Resource Retirement Aids in US, EU and Japan (in US$ million).

Structural Adjustment through Producer/Resource Retirement Aids								
	1998		1999		2000		2001	
	Amount	Per cent	Amount		Amount	per cent	Amount	per cent
US	1,731	3	1,434	3	1,476	3	1,624	3
EU	1265.78	5.93	974.96	4.18	692.37	3.44	799.91	4.33
Japan	652.381	2.85	754.124	3.20	824.015	3.54	806.392	3.85

Note: Percentage figures are with reference to overall GB Support
Source: WTO Notifications. Currency conversions have been calculated using the Wikipedia Table of Historical Exchange Rates

Structural Adjustment through Investment Aids

The EU's expenditure on structural adjustment through investment aids programme comprised a significant portion of its overall expenditure on GB though the overall EU share of expenditure on this head has fallen from 28.18 per cent in 1998 to 25.92 per cent in 2001.

Table 9 Expenditure on Structural Adjustment through Investment Aids in US, EU and Japan (in US$ million)

Structural Adjustment through Investment Aids								
	1998		1999		2000		2001	
	Amount	per cent	Amount		Amount	per cent	Amount	per cent
US	93	0.19	134	0.27	132	0.26	106	0.21
EU	6014.14	28.18	6120.82	26.21	5721.49	28.42	4792.13	25.92
Japan	591.27	2.58	476.70	2.02	476.70	2.02	348.89	1.66

Note: Percentage figures are with reference to overall GB Support
Source: WTO Notifications. Currency conversions have been calculated using the Wikipedia Table of Historical Exchange Rates

Environmental Programme Payments

Direct payments to producers under environmental programmes qualify as GB payments if they are part of a clearly defined government environmental or conservation programme and are also dependent on the fulfilment of specific conditions under the government programme including conditions related to production methods or inputs. The amount of payment under this is limited to the extra cost or loss of income from complying with such conditions.

Table 10 Expenditure on Environmental Programme Payments in US, EU and Japan (in US$ million)

	Environmental Programme Payments							
	1998		1999		2000		2001	
	Amount	per cent	Amount		Amount	per cent	Amount	per cent
US	297	0.60	332	0.67	309	0.62	291	0.57
EU	5528.45	25.90	5815.79	24.91	5274.83	26.21	4938.70	26.71
Japan	883.08	3.85	1083.34	4.59	516.87	2.22	1450.68	6.92

Note: Percentage figures are with reference to overall GB Support
Source: WTO Notifications. Currency conversions have been calculated using the Wikipedia Table of Historical Exchange Rates

Environmental payments comprise a significant portion of the EU's GB expenditure and have increased from 25.9 per cent in 1998 to 26.71 per cent in 2001. The US expenditure has not been very significant under this head. Japan's environmental payments have increased from 3.8 per cent in 1998 to 6.92 per cent in 2001. Although it is argued that environment subsidies are hardly production and trade distorting, distortions are indeed possible. For instance GB support under this head might affect costs through the introduction of more cost reducing environmentally friendly technologies which might not have been otherwise adopted due to fixed costs now being covered by the subsidies. Environmental payments might also affect production decisions in the same manner as general services by increasing productivity.

Regional Assistance Programmes

In terms of regional assistance programmes the US has not notified any expenditure in this category. The EU's expenditure on such programmes had increased from 10.6 per cent in 1998 to 14.83 per cent in 2000 but thereafter declined to 11.71 per cent in 2001.

Table 11 Expenditure on Regional Assistance Programmes in US, EU and Japan (in US$ million)

	Regional Assistance Programmes							
	1998		1999		2000		2001	
	Amount	per cent	Amount		Amount	per cent	Amount	per cent
US	0	0	00	0	0	0	0	0
EU	2272.58	10.65	3089.39	13.23	2984.34	14.83	2165.91	11.71
Japan	-	-	-	-	306.22	1.32	271.54	1.30

Note: Percentage figures are with reference to overall GB Support
Source: WTO Notifications. Currency conversions have been calculated using the Wikipedia Table of Historical Exchange Rates

Conclusion

It can be seen that the US has steadily maintained quite a high proportion of GB expenditure from 1995 onwards. In EU the share of GB expenditure in the overall domestic support has increased from 1995 onwards. In the case of Japan also it can be seen that there has been an increase in the share of GB in the overall domestic support from 47% in 1995 to 75% in 2001. It is further observed that while for US the most significant categories of GB expenditure are domestic food aid and general services respectively, for EU it is general services followed by investment aid. In Japan the most significant category of GB expenditure is general services. Environmental payments also comprise an increasingly important part of GB expenditure in both the EU and Japan. Over this period there has been a change in farm support policies in US, EU and Japan which has led to a shift of domestic support to agriculture from Amber Box measures to GB measures. Further it can be seen that while there has been a decline in the magnitude of all subsidies provided, the decline in GB has not been proportionate to the decline in other subsidies and at times there has also been an increase in GB subsidies compared to other subsidies. This might be an indication of box shifting.

III. DEA ANALYSIS AND CGE MODELLING

Earlier in the paper theoretical arguments were advanced to show how GB subsidies might have an impact on trade and production This chapter examines as explained above the trade and production effects of GB using Data Envelopment Analysis (DEA) and CGE modelling. DEA is a widely used technique for estimating the impact of subsidies on output. DEA allows comparison of total factor productivity (TFP) across countries with and without subsidies. With DEA analysis it is possible to compare the sources of productivity improvements across countries It not only provides comparable percentage changes in productivity but also decomposes TFP into technical change and technical efficiency. Productivity enhancement leads to reduction in cost of production thus resulting in an improvement in cost efficiency. Therefore DEA is also used to estimate cost efficiencies across countries. To translate the results of DEA into effects on production and trade, CGE modelling is used. An improvement in total factor productivity and a corresponding rise in cost efficiency can result in changes in the pattern of global production and trade.These changes are quantified through CGE modelling. This is a comprehensive methodology for taking account of simultaneous changes across countries.

Data Envelopment Analysis (DEA) Estimation

DEA is a linear-programming methodology, which uses data on the input and output quantities of a group of countries to construct a piece-wise linear surface over the data points. A frontier surface is then constructed by the solution of a sequence of linear programming problems—one for each country in the sample. The degree of technical change of each country (the distance between the observed data point and the frontier) arrived at is a by-product of the frontier construction method.

DEA can be either input-oriented or output-oriented. In the input-oriented analysis, the DEA method defines the frontier by seeking the maximum possible proportional reduction in input usage, with output levels held constant, for each country. In the output-oriented analysis, the DEA method seeks the maximum proportional increase in output production, with input levels held fixed. The two measures provide the same technical efficiency scores when a constant returns to scale (CRS) technology applies, but are unequal when variable returns to scale (VRS) are assumed[14]. This paper assumes VRS technology and selects the output oriented

[14] Agricultural production is generally assumed to have variable returns to scale

approach for calculating production efficiency since it is fair to assume that, in agriculture, one usually attempts to maximize output from a given set of inputs, rather than the converse[15]. For calculating cost efficiencies, however, this paper uses an input oriented approach.

The DEA analysis may be divided into three parts. ***First,*** total factor productivity growth for 25 countries for the period 1995–2000 is estimated using Malmquist indices[16], which are defined by distance functions. One output and three inputs (land, labour and capital) are used to construct these indices. This constitutes a base line frontier. ***Second***, the same exercise is undertaken with GB expenditure as an additional input. Total factor productivity growth is further decomposed into technical efficiency (TE) growth and technical change (TECHCH), which is represented by a shift in the production frontier. However, since the two TFP estimates have been obtained using two different frontiers, the relative distances from the frontier are estimated for each country. The difference in the relative TFP scores gives the change in TFP on account of GB expenditure. ***Third***, cost efficiency (CE) is estimated for the year 2000 with and without GB expenditures. Here domestic food aid, public stock holding for food security purposes and relief from natural disaster components are removed from total GB expenditure to arrive at the adjusted GB expenditures.[17] The relative improvement in cost efficiency for each country is estimated, as in the earlier case, by calculating the change in its relative distance from the frontiers. Using this, the change in cost efficiency due to GB expenditures is estimated through an input oriented approach. These changes are then used as shock variables in the CGE modelling to determine output and trade changes in different countries.

15 This has also been argued by Tim Coelli and Prasada Rao (2003).

16 Explained further in Appendix 1

17 Public stockholding for food security purposes and Natural disaster relief payments have an economic justification since they ameliorate market failures .The effect of food aid component on cost of production is found to be insignificant in the subsequent Cobb Douglas Estimate. Hence this paper removes these three categories of GB from the DEA and CGE analysis.

Malmquist TFP Indices

As a first step Malmquist indices are calculated. Malmquist indices help reaffirm the robustness of the results obtained from the estimation of cost efficiencies. To estimate the change in TFP, TE and TECHCH, with and without GB expenditures, the countries are categorized as high GB, medium GB and low GB spending in the period 1995–2000. US, Japan and EU are categorized as countries with high GB expenditures. These are reported in Table 12 below.

Table 12 Average GB Expenditure (US$ million) 1995–2000.

High GB	United States	50277
	Japan	25077
	EU	23953
Medium GB	Korea, Rep.	4972
	Brazil	3238
	Switzerland	2331
	India	2196
	Mexico	1508
	Thailand	1248
	Canada	1178
Low GB	Australia	787
	Poland	677
	Venezuela, RB	598
	Norway	567
	South Africa	557
	Pakistan	359
	Morocco	279
	Philippines	264
	Colombia	253
	Indonesia	248
	Argentina	231
	Malaysia	217
	Czech Republic	170
	Peru	143
	Chile	140
	New Zealand	128
	Sri Lanka	108
	Trinidad and Tobago	63
	Tunisia	43
	Iceland	42
	Paraguay	38
	Costa Rica	32

GB expenditures of US, EU and Japan are more than six times that of medium GB countries.

Estimation of TFP Changes

The average TFP, TE and TECHCH scores estimated with Malmquist indices for 25 countries for the period 1995–2000 are reported in Table 13[18]. The analysis uses agricultural arable land, agricultural labour and number of tractors as inputs, where the data are collected from *World Development Indicators* (2006). GB expenditure is used an one of the inputs in the calculation of these scores. The estimates show that maximum TFP growth in this period has occurred in US (9.6 per cent) followed by Japan (6.2 per cent) and Brazil (5.9 per cent). EU has also witnessed TFP growth of 2.0 per cent. Interestingly, in countries with very high GB, that is, U.S, EU and Japan, it is found that most of the growth in TFP is explained by technical change rather than improvement in technical efficiency. The negative impact of subsidies on technical efficiency in agriculture is also supported by empirical studies like Rezitis et al (2003) and Giannakas et al (2001) for Greece and Canada respectively which show that subsidies may reduce incentives for efficiency improvements.

On the other hand, there was a drastic technical change for US in this period. EU and Japan also experienced positive technical change of 1.8 per cent and 5.5 per cent respectively. A rise in Research and Development expenditures may have shifted the production frontier outwards. Making expensive technologies available at a lower price could also have enabled farmers to produce more. Similar effects of subsidy on technical change in agriculture have been found by Guyomard et al (2006) for France in the period 1995 to 2002 using a comparable methodology.

Table 13 Mean of Total Factor productivity, Technical Efficiency and Technical Change with GB Expenditures (Malmquist Indices).

S. No.		Country	Technical Efficiency Change	Technical Change	Pure Efficiency Change	Scale Efficiency Change	Total Factor Productivity Change
1	**High GB**	EU	1.002	1.018	0.979	1.024	1.020
2	**High GB**	Japan	1.006	1.055	1.000	1.006	1.062
3	**High GB**	United States	1.000	1.096	1.000	1.000	1.096
4	Medium GB	Brazil	1.019	1.039	1.000	1.019	1.059
5	Medium GB	Canada	1.000	1.027	1.000	1.000	1.027
6	Medium GB	India	0.987	1.000	0.945	1.044	0.987
7	Medium GB	Korea, Rep.	1.000	1.001	1.000	1.000	1.001
8	Medium GB	Mexico	0.984	1.031	0.950	1.034	1.015
9	Medium GB	Poland	0.914	1.067	0.856	1.068	0.975
10	Medium GB	Switzerland	0.980	1.036	0.998	0.982	1.015
11	Medium GB	Thailand	0.959	1.056	0.991	0.969	1.013

[18] All indices are relative to the previous year. For each of the indices 1.000 indicates no change.For example a Total Factor Productivity Index of 1.000 indicates no change and an index of 1.059 indicates a change of 5.9%.

12	Low GB	Argentina	1.016	1.000	1.000	1.016	1.016
13	Low GB	Australia	1.000	1.048	1.000	1.000	1.048
14	Low GB	Chile	0.907	1.000	0.918	0.989	0.097
15	Low GB	Czech Republic	1.016	0.984	1.000	1.016	1.000
16	Low GB	Indonesia	0.955	0.987	0.939	1.017	0.942
17	Low GB	Malaysia	1.049	1.000	1.000	1.049	1.049
18	Low GB	Morocco	1.000	0.983	1.000	1.000	0.983
19	Low GB	Norway	0.984	1.034	1.000	0.984	1.017
20	Low GB	Pakistan	1.005	1.000	1.000	1.005	1.005
21	Low GB	Peru	1.003	1.000	1.003	1.000	1.003
22	Low GB	Philippines	1.020	1.000	1.000	1.020	1.020
23	Low GB	South Africa	1.092	1.035	1.094	0.998	1.130
24	Low GB	Sri Lanka	1.015	1.000	1.000	1.015	1.015
25	Low GB	Venezuela, RB	1.020	1.020	1.010	1.010	1.040

Note: A value of 1.00 indicates the there has been no change in the variable. Indices higher than 1.00 indicate percentage increase of that magnitude.

Upon decomposing the TFP it is found that for most of the low GB countries, except for South Africa, no significant technical change has occurred in this period.

To estimate the impact of GB expenditures on TFP, TE and TECHCH for each country the difference in TFP with the frontier country is estimated. The difference in the relative distances gives the change due to GB expenditures in TFP, TE and TECHCH. The results are reported in Table 14.

Table 14 Change in TFP, Technical Change and Change in TE due to GB Expenditures (per cent): 1995 to 2000.

S.No	Extent of GB	Country Name	Change in TFP due to GB	Change in TECH due to GB	Change in TE due to GB
1	High GB	EU	2.0	1	-2.5
2	High GB	Japan	4.2	2.6	-4.6
3	High GB	United States	2.9	2.2	-1.5
4	Medium GB	Brazil	2.0	3.6	-0.1
5	Medium GB	Canada	-3.0	-0.1	-1.5
6	Medium GB	India	-0.3	-2.8	0.1
7	Medium GB	Korea, Rep.	1.8	2.8	-1.5
8	Medium GB	Mexico	1.3	1.2	1.5
9	Medium GB	Poland	-1.2	1.9	-1.6
10	Medium GB	Switzerland	3.0	2.1	-1.1
11	Medium GB	Thailand	0.5	1.6	-1.4
12	Low GB	Argentina	-1.8	-1	-1.3
13	Low GB	Australia	-1.6	-1.6	-0.5
14	Low GB	Chile	-5.9	0.7	-0.8
15	Low GB	Czech Republic	-3.1	-4.3	0.2
16	Low GB	Indonesia	-5.8	-4.1	0.1
17	Low GB	Morocco	-2.5	-4.6	1.5
18	Low GB	Norway	-0.2	-1.1	-2.5

19	Low GB	Pakistan	-4.1	-1.6	0.1
20	Low GB	Peru	-0.3	-5.7	2.8
21	Low GB	Philippines	1.2	-4.8	3.7
22	Low GB	South Africa	1.8	3.5	0.6
23	Low GB	Sri Lanka	-0.2	-0.3	1.6
24	Low GB	Venezuela, RB	-1	1.6	1.5

The results show that there has been an increase in TFP on account of GB expenditures in all three high GB countries. Japan has experienced the highest increase of 4.2 per cent. Productivity growth has declined relative to the frontier in most of the developing countries, especially the ones with low GB expenditures as US defines the frontier. Korea, Switzerland and Thailand, which are medium GB expenditure countries, experience a rise in their productivity with GB expenditures.

GB expenditures account for 2.2 per cent of technical change in US. For medium GB countries, such as Thailand, Mexico, Korea and Switzerland it leads to improvement in relative positions with respect to technical change, while those of low GB countries worsen. Technical efficiency, on the other hand, improves in countries with low GB expenditures but declines for the high GB countries. Similar results with respect to technical efficiency (that is, no change in TE in US and a decline in technical efficiency in Japan) have also been found by Coelli and Rao (2003) who estimate Malmquist indices for US agriculture for the period 1980 to 2000. Guyomard et al (2006) also find that CAP direct payments expressed as a share of farm revenue in France in the period 1995 to 2002 had a negative impact on technical efficiency. GB subsidy may therefore reduce incentives for improving efficiency, though over time these payments may help the farmers to get closer to their frontier due to significant enhancement of productivity growth.

Estimation of Cost Efficiencies

Deterministic DEA

To translate the impact of productivity changes with and without GB expenditures on output and trade to cost efficiency changes, cost efficiencies are estimated using input-oriented DEA approach. A similar methodology is followed whereby two cost frontiers are estimated, with and without GB expenditures. For a particular country, change in relative distance from the two frontiers is arrived at. The difference between the two distances gives the change in cost efficiency of the country which can be attributed to GB expenditures.

Availability of cost data is limited; cost efficiencies have been estimated for the year 2000 for select countries where comprehensive data is available. Adjusted GB expenditure excluding subsidies for public stock holding, domestic food aid, relief from natural disasters and others is used for our purposes because it is expected that these categories may not affect cost of production, Notifications for the latest available years are used to disaggregate GB expenditures. The adjusted GB expenditures are reported in Table 15.

Table 15 Decomposition of GB Expenditures in US Million Dollars (For the year 2000).

Serial no.	Extent of GB	Country	Unadjusted GB	Adjusted GB	Food Aid Component (per cent)
1	**High GB**	**EU**	**20,125.76**	**19,516.40**	**3.0**
2	**High GB**	**Japan**	**24081.841**	**23,081.00**	**4.2**
3	**High GB**	**United States**	**50,057.00**	**15,540.00**	**69.0**
4	Medium GB	Brazil	1,486.00	856.00	42.4
5	Medium GB	Canada	1,594.49	1,594.49	0.0
6	Medium GB	India	2,872.85	411.25	85.7
7	Medium GB	Korea, Rep.	4468.7	4271	4.4
8	Medium GB	Mexico	508.21	508.21	0.0
9	Medium GB	Poland	557	490.12	12.0
10	Medium GB	Switzerland	2031.57	2026.06	0.3
11	Medium GB	Thailand	977.53	977.53	0.0
12	Low GB	Argentina	156.23	156.23	0.0
13	Low GB	Australia	752.17	729.85	3.0
14	Low GB	Chile	108.85	108.85	0.0
15	Low GB	Czech Republic	171.82	139.99	18.5
16	Low GB	Indonesia	507.18	125.40	75.3
17	Low GB	Malaysia	130.21	130.21	0.0
18	Low GB	Morocco	250.424	61.64	75.4
19	Low GB	Norway	569.384	536.15	5.84
20	Low GB	Pakistan	238.42	230.24	3.4
21	Low GB	Peru	279.7	223.4	20.1
22	Low GB	Philippines	293.28	262.06	10.6
23	Low GB	South Africa	392.35	392.35	0.0
24	Low GB	Sri Lanka	72.92	9.71	86.7
25	Low GB	Venezuela, RB	605.84	71.78	88.2

Assuming the duality theorem cost efficiencies are estimated[19]. Cost efficiency is defined as the ratio of minimum cost to the observed cost. Given the input prices, cost efficiency is further decomposed into allocative efficiency and technical efficiency.

[19] The duality theorem states that if, in the primal problem, we minimize an objective function with respect to a given constraint, then in the dual problem, we maximize that constraint subject to a given objective function. The cost-minimization and the output-maximization problem fulfill this duality relationship.

Estimating cost efficiency using DEA has a major advantage, which is that these methods do not require actual price data. This is a distinct advantage, because in general, agricultural input price data is seldom available and such prices could be distorted due to government intervention in most developing countries. However, an important point needs to be added here. Even though the DEA- based productivity measures may not explicitly use *market price* information, they do *implicitly* use 'shadow price' information. This issue is discussed in some detail in Coelli and Prasada Rao (2001).

Accordingly, for capital price, lending rates[20]are used as shadow price for the estimations. Wages of agriculture labour, as reported in World Development Indicators (2006), are used as price of labour. Inputs used are land, number of tractors,[21] agricultural labour and Green Box expenditures.

The results of cost efficiency derived using GB as an input and without using GB as an input are presented in Table 16.

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[20] Lending rates are taken from International Financial Statistics.

[21] This variable has also been used by Coelli and Prasada (2003) in their estimations of productivity using Malmquist indices.

Table 16 Cost efficiency and Change in Cost Efficiency with GB Expenditure (Deterministic DEA).

Country	Adjusted GB	Technical Efficiency	Allocative Efficiency	Change in Cost Efficiency with and without Adjusted GB (per cent)
Japan	23,081.00	0.789	0.468	24.00
EU	19,516.40	0.695	0.711	16.7
United States	15,540.00	1.00	1.00	15.3
Korea, Rep.	4271	1.00	0.218	2.00
Switzerland	2026.06	0.812	0.371	30.80
Canada	1,594.49	1.00	0.836	16.4
Brazil	856.00	0.342	0.168	1.3
Australia	729.85	1.00	0.808	4.1
Mexico	508.21	0.461	0.123	1.1
Poland	490.12	0.071	0.424	1.0
India	411.25	0.53	0.021	0.1
Philippines	262.06	1.00	0.003	1.3
Pakistan	230.24	0.283	0.064	-0.2
Argentina	156.23	0.679	0.146	13.5
Czech Republic	139.99	0.318	0.314	-0.9
Malaysia	130.21	1.00	0.117	0.6
Indonesia	125.40	0.759	0.019	-0.1
Romania	86.87	0.256	0.261	-0.4
Morocco	61.64	1.00	0.03	0.1
Paraguay	25	0.792	0.078	0.3
Sri Lanka	9.71	1.00	0.021	0.1
Jamaica	8.22	0.736	0.065	3.0

Note: Adjusted GB excludes Food Aid Component of GB. Cost Efficiency is a product of technical efficiency and allocative efficiency

The results show that the relative change in cost efficiency with adjusted GB is highest for Switzerland followed by Japan. This implies that GB expenditures in Switzerland and Japan are the most cost reducing expenditures. This is plausible as the food aid component in both the cases is very small (Table 12). Both US and EU experience a cost reduction of around 15 per cent to 17 per cent respectively with GB expenditures.

The two other countries where GB expenditure is significantly cost reducing are Canada and Argentina, where again food aid component is almost nil.

Interestingly, there has been a marked shift within GB expenditures in Argentina. General services constituted around 28 per cent of total GB expenditure in 1997. This increased to almost 77 per cent of total GB expenditures in 2000. Most of the developing countries become

relatively less cost efficient with the GB expenditures included in the analysis as the frontier shifts further inwards.

Stochastic Frontiers

The deterministic DEA analysis which has been used to estimate the impact of GB expenditures on agricultural productivity and cost efficiency is non parametric and hence is particularly vulnerable to measurement errors. The deterministic approach constrains the error term of the cost function to be non-negative. Greene (1980) has shown that the resulting constant term is consistent but biased and of unreliable efficiency. Nevertheless many studies have used this approach.

This problem can be overcome using the stochastic cost frontier approach suggested by Aigner et al. (1977). In this specification the error term is composed of two uncorrelated parts: The first part *ui*, is a one-sided non negative disturbance reflecting the effect of inefficiency (including both allocative and technical inefficiencies), and the second component *vit* , is a symmetric disturbance capturing the effect of noise. Usually the statistical noise is assumed to be normally distributed, while the inefficiency term *ui* is generally assumed to follow an exponential or a truncated normal distribution. The main advantage of the stochastic cost frontier approach compared to the deterministic approach is the separation of the inefficiency effect from the statistical noise.

To mitigate this concern about deterministic DEA and have robust results of cost efficiency gains, an attempt has been made to estimate cost efficiency with and without GB using stochastic frontier cost function. To explain briefly, a stochastic frontier cost function specifies error term ($V_i + U_i$) and cost function is defined by:

$Y_i = x_i\beta + (V_i + U_i)$,i=1,...,N,

where Y_i is the (logarithm of the) cost of production of the i^{th} firm;

x_i is a k×1 vector of (transformations of the) input prices and output of the i^{th} firm;

β is a vector of unknown parameters

the V_i are random variables which are assumed to be iid $N(0,\sigma_V^2)$, and independent of the

U_i which are non-negative random variables which are assumed to account for the cost of inefficiency in production, which are often assumed to be iid $|N(0,\sigma_U^2)|$.

In this cost function the U_i now defines how far the firm operates above the cost frontier. If allocative efficiency is assumed, the U_i is closely related to the cost of technical inefficiency. If this assumption is not made, the interpretation of the U_i in a cost function is less clear, with both technical and allocative inefficiencies possibly involved. Thus efficiencies measured relative to a cost frontier shall be referred to as 'cost' efficiencies in the remainder of this document. The exact interpretation of these cost efficiencies will depend upon the particular application. The cost frontier is identical to the one proposed in Schmidt and Lovell (1979).

The cost efficiencies have been estimated for countries where the data is available. The data set is same as that used in determinist DEA cost efficiency gains.

The results in table 17 report the cost efficiency scores which show that with Adjusted GB and without GB expenditures the relative change in cost efficiency is highest for Canada followed by EC. This implies that GB expenditures in EC and Canada are the most cost reducing. Australia, US, Japan and Switzerland also experience a significant cost reduction of around 39.7 per cent, 27 per cent, 25 per cent and 18 per cent respectively with GB expenditures.

The developing countries where Green Box expenditure is significantly cost reducing are Argentina (15 per cent), where again food aid component is almost nil. Interestingly, there has been a marked shift within Green Box expenditures in Argentina. General services constituted around 28 per cent of total Green Box expenditure in 1997. This increased to almost 77 per cent of total GB expenditures in 2000. As explained above General services and environmental services had the most significant effect among the GB subsidies.

Table 17 Cost efficiency and Change in Cost Efficiency with GB Expenditure

Country	Cost Efficiency Scores With GB	Cost Efficiency scores without GB	**Change in Cost Efficiency with GB and without GB (per cent)**
Argentina	17.377	1.6654	15.71
Australia	41.493	1.7912	39.70
Brazil	16.13	1.6471	14.48
Canada	69.568	2.0399	67.52
Czech Republic	9.3704	1.5829	7.78
EC	59.207	4.7419	54.46
India	30.407	4.0334	26.37
Indonesia	13.061	2	11.06
Japan	31.955	6.7133	25.24
Jamaica	3.0902	1.2936	1.79
Korea, Rep.	5.9814	1.9883	3.99
Malaysia	10.284	1.702	8.58
Mexico	8.0995	1.789	6.31
Morocco	52.98	1.5783	51.40
Pakistan	10.781	2.0825	8.69
Paraguay	9.6845	1.3718	8.31
Philippines	4.2649	1.8335	2.43
Poland	7.8626	1.6532	6.20
Romania	19.153	1.3491	17.80
Sri Lanka	61.186	1.6162	59.56
Switzerland	20.458	1.7667	18.69
United States	29.738	2.8335	26.90

Minor gains for other developing countries are observed and this is in line with expectations, given the small magnitude of GB provided by developing countries

Comparing these results with deterministic DEA cost efficiency as reported in Table 16, efficiency gains can be noted for all countries due to GB, though the value of efficiency gains is different from each method. These differences are inevitable because the two approaches are based on different assumptions. The stochastic DEA assumes a functional form while deterministic DEA assumes a mathematical relation. The former has an error term while the latter does not. Both methods have their advantages and disadvantages, so neither is clearly preferable (Resti 2000; Reinhard, Lovell, and Thijssen 2000). Despite the differences, both the DEA approaches (stochastic and deterministic) provide that GB has significant cost reducing effect for developed countries. However there are some limiting assumptions in stochastic

DEA which do not accord with our understanding of the real world. Therefore, deterministic DEA which does not use these assumptions is used for GTAP CGE analysis. This method is not subject to the potential criticism of having an arbitrary assumption about the distribution of the random terms, which is rarely fulfilled.

CGE Modelling

GTAP model used here is capable of analysing the economy-wide effects of changes in international trade variables such as tariff protection/ taxation/subsidy. The database used is taken from GTAP as compiled by the Centre for Global Analysis, Purdue University, USA. The 57 GTAP commodity categories are aggregated under three heads for this analysis. Similarly, the 87 countries/regions are aggregated into 28 countries/regions for the model (**See** Appendix-2)[22].

Reduction of GB subsidies will raise costs and prices. The extent of increase in costs is derived from the DEA analysis as explained above by using cost efficiency estimates. The interpretation is that without GB subsidies costs will rise by the amount indicated by cost efficiency estimates. Assuming perfect competition, the rise in cost of production will lead to an equivalent rise in prices. As domestic prices are considered endogenous in the GTAP database, it is assumed that an increase in costs of production subsequent to the reduction of GB will increase export prices of countries providing large amounts of GB. In the model export prices of EU, USA, Japan, Canada, Korea and Switzerland are hiked up by the amount of their cost increase subsequent to the reduction of GB. These countries were selected because they provide the maximum amount of GB subsidies in the world, exceeding that of others by several multiples as shown in table 15 above.

The effect of GB subsidies on agricultural output and trade is presented in Table 18. There is a significant decrease in output in most of the developed countries while there is an increase in agricultural output of most developing and least developed countries with the reduction of GB subsidies.

[22] There are some limitations of our CGE modeling in GTAP. The CGE modeling is based on the standard assumption of perfect competition. It is a deterministic model and does not capture the effect created by noises in the economy. Given the static nature of the model, it is not possible to capture dynamic linkages in the economy. Undoubtedly, CGE modeling in GTAP is based on very restrictive assumptions. Nevertheless, evaluation studies suggest that the CGE models predict the direction and the pattern of trade relatively well. Since the scale largely depends upon the functional forms and elasticities, the development of new functional forms and estimation of more reliable elasticities will provide better results.

Table 18 Estimated Effect of GB subsidies on Production and Trade (percentage change)

Countries	Output	Imports	Exports
Other Developed Countries (Devd)	10.31	-5.94	15.62
European Union	-5.62	-21.27	-44.56
United States of America	-2.23	-16.06	-39.03
Canada	-9.19	-24.05	-46.33
Argentina	4.32	-2.66	13.76
Australia	7.28	-10.55	16.75
Norway	10.59	-14.54	26.36
Brazil	5.13	-4	21.04
Chile	5.9	-2.24	17.98
India	1.22	-5.77	21.87
Venezuela	1.69	-11.22	26.85
Indonesia	3.11	-7.56	15.89
Thailand	5.01	-3.38	10.06
Morocco	5.53	-13.25	23.75
Poland	3.98	-15.92	25.53
South Africa	6.45	-5.98	24.73
Switzerland	-7.74	-20.13	-77.98
Romania	2.11	-12.7	28.8
Slovenia	7.04	-13.04	21.22
Peru	3.3	-7.12	19.57
Japan	1.24	-12.39	-66.49
Korea	2.59	-6.84	3.85
Philippines	2.14	-8.24	14.04
Mexico	3.13	-20.36	14.87
Czech Republic	6.16	-13.34	25.4
Malaysia	9.13	-0.41	13.48
Developing Countries (DCs)	3.51	-11.14	22.04
Least Developed Countries (LDCs)	3.05	-8.52	20.54

For instance, agriculture output in US, EU, Canada and Switzerland decreases by -2.23, -5.62, -9.19 and -7.74 percent. A plausible reason for why output does not decline very substantially in US after the removal of GB subsidies as compared to other countries like EU and Canada can be that the US is found to be closer to the frontier without GB subsidies (Table 19). As a result removal of GB does not affect its output much. However, exports of US fall more than proportionately without GB subsidies since in this scenario other countries become relatively more competitive in agriculture than US. The decline in output is maximum in Canada and Switzerland pointing perhaps to the fact that technical efficiency in these countries in a static sense may not be high, hence reduction of GB would lead to a substantial increase of about 16 per cent in the cost of production. At the same time the increase in output is the highest in competitive agricultural countries such as Argentina, Chile, Brazil, and South Africa which

register production increases between 4.5 and 7 per cent. Overall global agricultural output rises by 0.13 percent (Table 19). While this increase is marginal, the non-negative effects on global output, contradict predictions about global food shortages consequent to the reduction of GB. These results also highlight the redistribution of global output in favour of competitive agricultural producers especially developing countries, and a commensurate reduction in trade distorting production of developed countries.

Table 19 Country Specific and Global Change in Agricultural Output. (US$ Million)

Countries	Percent Change	With GB	Without GB	Absolute change
Other Developed Countries (Devd)	10.31	17094.37	18856.04	1761.67
European Union	-5.62	958104.38	904272.75	-53831.63
United States of America	-2.23	937664.69	916747.75	-20916.94
Canada	-9.19	88035.23	79943.86	-8091.38
Argentina	4.32	58978.22	61523.78	2545.55
Australia	7.28	55137.92	59154.29	4016.37
Norway	10.59	17084.35	18892.78	1808.43
Brazil	5.13	103984.17	109322.76	5338.59
Chile	5.9	23097.45	24459.48	1362.03
India	1.22	172003.7	174098.09	2094.39
Venezuela	1.69	32032.13	32574.2	542.07
Indonesia	3.11	58997.15	60829.75	1832.6
Thailand	5.01	36652.18	38490.05	1837.88
Morocco	5.53	13933.85	14704.79	770.94
Poland	3.98	54688.13	56865.82	2177.7
South Africa	6.45	25382.66	27020.75	1638.08
Switzerland	-7.74	22277.19	20552.73	-1724.46
Romania	2.11	19120.72	19524.04	403.32
Slovenia	7.04	4227.29	4525.04	297.76
Peru	3.3	17663.55	18246.02	582.46
Japan	1.24	392428.09	397310.19	4882.09
Korea	2.59	70005.57	71819.27	1813.7
Philippines	2.14	38239.2	39058.18	818.98
Mexico	3.13	140705.92	145111.56	4405.64
Czech Republic	6.16	15760.31	16731.51	971.21
Malaysia	9.13	15657.58	17087.27	1429.69
Developing Countries (DCs)	3.51	1194329.25	1236293.13	41963.88
Least Developed Countries (LDCs)	3.05	180261.19	185761.94	5500.75
Total Output	0.13	4763546.44	4769777.82	6231.38

Because of the rise in prices following the reduction of GB, imports of all countries would decrease as shown in table 18, with Switzerland, EU and Canada showing the highest decline of over 20 per cent. This could lead to increased self-sufficiency in agriculture at the global level. Exports from developing countries increase include those from LDCs, while those from developed countries decrease significantly. For example, agricultural exports from US, EU, Canada and Switzerland decrease by 40–80 per cent, while exports from developing countries increase by as much as 26 per cent. Exports from LDCs also register a non-negligible increase. The changing pattern of international trade in agriculture would also help meet the development objectives of the Doha Work Programme.

The effects on employment of reducing GB subsidies are presented in Table 20. Agricultural employment of unskilled labour in developing countries rises while those in developed countries fall. For instance, agricultural employment in US, EU, Canada and Switzerland decreases between 2 and 10 per cent, while that of the most competitive developing countries increases by as much as 7 per cent. Only with few exceptions, the extent and direction of employment effect follow output effects. In the group of major GB subsidy providers, EU and Canada see a sharper fall in agricultural employment in comparison to the US. Similarly, more competitive countries gain more in terms of employment compared to less competitive ones. Further, there is a 1.13 percent increase in global agricultural employment, implying positive livelihood effects on agricultural labour. The distributional changes in employment would also favour developing countries.

Table 20 Estimated Employment Effect of reduction in GB in Agricultural Sector (Percentage Change)

Countries	Unskilled Labour	Skilled Labour
Other Developed Countries (Devd)	10.83	11.25
European Union	-5.83	-5.9
United States of America	-2.41	-2.43
Canada	-9.88	-9.99
Argentina	5.09	5.21
Australia	8.15	8.37
Norway	11.05	11.13
Brazil	5.72	5.67
Chile	6.81	7.34
India	1.66	1.88
Venezuela	1.91	2.04
Indonesia	4.09	4.78
Thailand	7.3	8.14
Morocco	5.9	6.66

Poland	4.48	4.71
South Africa	7.08	7.13
Switzerland	-8.04	-8.09
Romania	2.49	2.82
Slovenia	7.61	7.69
Peru	3.59	3.95
Japan	1.32	1.33
Korea	4.03	4.16
Philippines	2.52	3.41
Mexico	3.43	3.59
Czech Republic	6.87	7.03
Malaysia	11.31	11.71
Developing Countries (DCs)	4.22	4.62
Least Developed Countries (LDCs)	3.51	4.11
Global Changes	1.13	-1.11

Commensurate with increased agricultural employment, wages of unskilled labour in developing and poor countries rise, while they fall for some developed countries (Table 21). It can be inferred from these results that the reduction of GB subsidies would have poverty alleviating effects, not only through increasing agricultural employment but also through improving wages.

Table 21 Impact on Agricultural Wages. (Percentage Change).

Countries	Unskilled Labour Wages
Other Developed Countries (Devd)	2.780529
European Union	-0.450762
United States of America	-0.151978
Canada	-0.665886
Argentina	2.378934
Australia	1.525185
Norway	0.418581
Brazil	1.462496
Chile	1.645657
India	0.704635
Venezuela	0.122378
Indonesia	1.083255
Thailand	1.315871
Morocco	1.726833
Poland	0.659784
South Africa	0.693952
Switzerland	-0.315677
Romania	0.372775
Slovenia	0.238892
Peru	1.45782
Japan	0.059904
Korea	-0.053932
Philippines	2.130142

Mexico	0.405212
Czech Republic	0.458339
Malaysia	0.284838
Developing Countries (DCs)	0.578129
Least Developed Countries (LDCs)	1.61251
Global Changes	

The effect of elimination of GB subsidies on Net Food Importing Countries (NFICs) as a group is also computed. Tables 22–24 show the results. Removal of GB increases the agricultural production of NFICs by 4.14 per cent. Their imports decline by 10.32 per cent and exports increase by 22.59 per cent. Further it can be seen that in absolute terms the value of their increase in production is about three times the value of decline in their agricultural imports. Hence it is quite clear that the welfare of NFICs also increase as a result of elimination of GB expenditure.

Further, the positive effect of employment increase in the agriculture sector will not be outweighed by the negative effect of employment decrease in services and industry in absolute numbers. Table 22 reveals that the sum of the value (wage times quantity) of employment across all three sectors in all developing and least developed countries is positive.

Table 22 Sum of the Value Change in Employment in All Three Sectors

Country	Absolute Values
OTHER DEVELOPED COUNTRIES	454.4
EU	-10546.4
USA	-5560
CANADA	-1663.1
ARGENTINA	1980.2
AUSTRALIA	1720.2
NORWAY	221.2
BRAZIL	2305.3
CHILE	280.1
INDIA	1072.4
VENEZUALA	42.3
INDONESIA	374.9
THAILAND	292.9
MOROCCO	224.7
POLAND	378.6
SOUTH AFRICA	284.7
SWITZERLAND	-261
ROMANIA	40.4
SLOVENIA	18.1
PERU	158.6

JAPAN	825.7
KOREA	-72
PHILIPPINES	305.7
MEXICO	494.8
CZECHOSLAVAKIA	79.8
MALAYSIA	92.2
OTHER DEVELOPING COUNTRIES	6838.6
LESS DEVELOPED COUNTRIES	2147.7
Total	2531.2

Table 23 Removal of GB Effect on Net Food Importing Countries (in percentage terms)

	Production								
Qutput	USA	CAN	SWISS	JAPAN	EU	KOREA	Developed	Developing	NFIC
Agriculture	-2.34	-9.48	-7.8	1.15	-5.75	2.46	6.43	3.08	4.14
Manufacturing	0.37	1.84	1.06	-0.05	1.01	-0.04	-1.33	-1.33	-1.58
Services	0.03	0.11	0.03	-0.04	0.1	-0.21	-0.3	-0.22	-0.34
CGDS	0.09	-0.41	0.05	0.15	-0.26	-0.14	0.37	0.09	0.34
	IMPORTS								
Imports	USA	CAN	SWISS	JAPAN	EU	KOREA	Developed	Developing	NFIC
Agriculture	-15.67	-23.64	-20.04	-11.85	-21.1	-6.56	-9.99	-9.94	-10.32
Manufacturing	-0.48	0.1	0.08	-0.22	-0.09	-0.21	0.13	0.16	0.38
Services	-0.26	-0.77	-0.49	0.24	-0.45	-0.04	0.7	0.56	0.89
	EXPORT								
Exports	USA	CAN	SWISS	JAPAN	EU	KOREA	Developed	Developing	NFIC
Agriculture	-40.01	-46.97	-78.12	-66.78	-44.9	3.36	20.45	20.2	22.59
Manufacturing	1.19	2.84	1.62	-0.43	1.84	-0.16	-2.35	-2.64	-2.6
Services	0.24	1.68	0.56	-0.96	0.8	-0.84	-1.84	-1.8	-2.39
	Employment Effect								
Employment in Agriculture	USA	CAN	SWISS	JAPAN	EU	KOREA	Developed	Developing	NFIC
Land	-0.11	-0.53	-2.28	0.05	-0.45	0.04	0.54	0.27	0.27
Unskilled Labour	-2.53	-10.19	-8.1	1.22	-5.96	3.83	7.36	3.84	4.52
Skilled Labour	-2.55	-10.31	-8.15	1.23	-6.04	3.95	7.66	4.16	4.99
Capital	-2.51	-10.14	-8.12	1.22	-5.93	3.9	7.56	4.08	4.9
Natural Resources	0	-0.02	-0.01	0	-0.01	0.01	0.01	0.01	0.01

Table 24 Production Effects for NFICs

	BASE DATA								
Output	USA	CAN	SWISS	JAPAN	EU	KOREA	Developed	Developing	NFIC
Agriculture	937664.7	88035.23	22277.19	392428.1	958104.4	70005.57	328956.2	1565215	400859.6
Manufacturing	4427981	418544.7	146655.6	2180048	4468157	423536.4	1077323	4260134	835383.6
Services	12586357	736719.6	263885.8	4759208	9176874	475944.6	1969284	4279807	1324445
CGDS	1990636	144606	47923.26	1059681	1614488	109932.6	368187.1	1084920	321769.3
	Absolute Change								
Agriculture	-21979.4	-8350.09	-1737.6	4511.59	-55080.9	1724.99	21167.91	48236.13	16609.06
Manufacturing	16548.5	7706.69	1548.92	-1122.75	45282	-187.25	-14284.1	-56624.5	-13181.9
Services	3247	809.19	69.25	-1898.5	9121	-976.5	-5924.13	-9551	-4490
CGDS	1756.13	-597.75	22.43	1610.5	-4211.25	-155.84	1354.94	1022.38	1109.81
	Percentage change								
Qutput	USA	CAN	SWISS	JAPAN	EU	KOREA	Developed	Developing	NFIC
Agriculture	-2.34	-9.48	-7.8	1.15	-5.75	2.46	6.43	3.08	4.14
Manufacturing	0.37	1.84	1.06	-0.05	1.01	-0.04	-1.33	-1.33	-1.58
Services	0.03	0.11	0.03	-0.04	0.1	-0.21	-0.3	-0.22	-0.34
CGDS	0.09	-0.41	0.05	0.15	-0.26	-0.14	0.37	0.09	0.34

Table 25 Import Effects for NFICs

	Base Data								
Imports	USA	CAN	SWISS	JAPAN	EU	KOREA	Developed	Developing	NFIC
agriculture	55428.15	14682.2	6823.35	58035.79	206909.3	18697.92	49219.25	101877.7	61272.49
Manufacturing	1089452	198291.8	80897.83	287201.3	1858508	130385.4	522108.3	1041221	346933.6
Services	176125.4	33112.84	14535.52	84888.39	526861.9	27294.37	113653.5	189417.8	82001.82
	Absolute Change								
Imports	USA	CAN	SWISS	JAPAN	EU	KOREA	Developed	Developing	NFIC
agriculture	-8685.39	-3470.51	-1367.56	-6879.36	-43630.6	-1226.73	-4915.91	-10129.6	-6325.28
Manufacturing	-5259.5	202.98	61.43	-634.94	-1678.25	-269.92	668.16	1622.88	1324.03
Services	-461	-254.93	-71.7	205.85	-2350.06	-10.49	795.38	1064.08	727.3
	Percentage change								
Imports	USA	CAN	SWISS	JAPAN	EU	KOREA	Developed	Developing	NFIC
agriculture	-15.67	-23.64	-20.04	-11.85	-21.09	-6.56	-9.99	-9.94	-10.32
Manufacturing	-0.48	0.1	0.08	-0.22	-0.09	-0.21	0.13	0.16	0.38
Services	-0.26	-0.77	-0.49	0.24	-0.45	-0.04	0.7	0.56	0.89

Conclusion

In this section, DEA and CGE modelling were applied to see the trade and production distorting effects of GB. From the DEA analysis it was found that GB expenditures had an impact on productivity and cost efficiency of agricultural production. Plugging in the results of the DEA in the CGE model it was found that GB expenditure might also significantly affect agricultural output, imports, exports, wages and employment. Given the assumptions of CGE model, the analysis is focused on the direction of the effects. Despite the assumptions and proxies the CGE result appears quite consistent with the theoretical framework described earlier. Briefly, seven broad inferences may be drawn. First, agricultural production will increase in developing countries if GB subsidies are reduced; second, there will be mild positive impact on global agricultural production; third, agricultural imports will decline, leading countries towards greater self sufficiency; fourth, there are significant gains for developing countries in terms of export increase; fifth, agricultural wages in developing countries will rise; sixth, there will be an increase in agricultural employment in developing countries as well as global agricultural employment, implying positive livelihood effects on agricultural labour, and poverty alleviating effect on rural people in developing and poor countries and seventh, agricultural production will increase in net food importing countries.

Therefore, it can safely be concluded that GB subsides offered by developed countries are production enhancing and trade distortive.

IV. TRANSLOG AND COBB DOUGLAS COST ESTIMATES

The DEA analysis in the previous section depicted that GB subsidies have a productivity enhancing and cost reducing impact on agricultural production of countries that provide them. To ensure that the results are robust a detailed analysis of GB subsidies and its various components on the cost of production of five major crops in the US has been conducted. A Translog cost function has been estimated using panel data for the period 1975–2004[23]. Crop wise analysis, using a Cobb Douglas function for five different crops- rice, wheat, soybean, corn and cotton— which constitute the majority of crop production in the US has also been conducted.

Translog Cost Function

A translog function[24] is used to estimate the direct and indirect effects of explanatory variables such as input prices and subsidies on cost of production. A translog function is a combination of all possible first and second order terms in the logarithms of independent variables such as output, input prices and GB subsidies. The popular approach to estimating translog cost function is the share equation approach using Shepherd's lemma[25], which states that a small increase in the price of an input increases cost by an amount equal to the use of that input. The translog function contains a large number of parameters even for a relatively small number of inputs and outputs. As a result, its estimation via ordinary least squares is likely to result in imprecise parameter estimates due to multicollinearity[26]. In order to obtain robust estimates of

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23 The data for Green Box is available for the base years 1985–6 and then from 1995–6 onwards. It is assumed that no Green Box expenditures were given prior to 1985–6. From 1985–6 to 1995–6, same values of Green Box expenditures are assumed.

24 The translog specification carries large number of cross products terms as explanatory variables in the right side of the equation which sometimes causes multicollinearity. In small sample size, the estimation of translog cost function becomes less reliable as the degrees of freedom are small. Further, the coefficient of translog cost function has complex interpretation. At the same time, the advantage of using the translog specification is that separability between inputs and outputs is not imposed a priori as in the case with the Cobb-Douglas and the CES specifications.

25 Using Shepherd's lemma, the following share function for each input may be obtained.

$S_i = \frac{P_i X_i}{C} = \frac{\partial \ln C}{\partial \ln P_i}$, where *Si* is the cost share of input *i*. See Appendix 4.

26 Multicollinearity stands for correlation between two explanatory variables. The presence of high correlation distorts the results.

standard errors, bootstrapping[27] has been used. Generalized Least Squares method which corrects for heteroscedasticity[28] and autocorrelation[29] is also applied.

Variables and Data Sources

Translog cost functions are estimated for adjusted GB subsidies and also for the individual constituents—subsidies on general services, subsidies for environmental programmes and decoupled payments. It is not possible to take all three constituents simultaneously because subsidies on general services and environmental services are highly correlated with a correlation coefficient of 0.99. The results for each translog specification are given in Tables 25–28.

The data on cost is constructed from available inputs and their prices. The data on agricultural output (y), cost of production (cost), rent (ldpcp), wages (lbpcp), interest rate (int), fertilizer price (Fertcp) are obtained from the website of US department of agriculture[30]. Expenditure on GB subsidies[31] (gbdef), subsidies on general services (gsdef), environmental subsidies (env) and decoupled payments (decoup) are obtained from WTO notifications. Squared term for output (ysq), and GB subsidies and its constituents (gbdefs, gsdefs, envdefs, decoups) are constructed from original series. Similarly, cross price terms are generated by multiplying the price variables (intfertcp, rentfertcp, rentwages, wageint, wagefertcp). The cross products of subsidies and output are also generated from the log of original data (ygb, ygs, yenv, ydc)[32]. The interaction term of output with interest, wage rate, rent and fertilizer price (yint, ywagecp, yrentcp, yfertcp) are obtained by multiplying the log values of output with log values of input prices. The interaction term of GB subsidies and its constituents with interest, wage rate, rent and fertilizer price (Gfertcp, Grentcp, Gwagecp, Gint,Gsfertcp, Gsrentcp, Gswagecp, Gsint Envfertcp, Envrentcp, Envwagecp, Envint, Envwagecp, Envint, Dcfertcp, Dcrentcp,

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27 Bootstrapping is the statistical procedure which uses the process of repeated sampling from the population to reduce sampling errors.

28 Violation of the assumption of constant variance over whole range of data, that is, statistically assumption is $E[u_i - E(u_i)]^2 = E(u_i^2) = \sigma^2$

29 Violation of the assumption of no covariance in residuals over time, i.e, statistically assumption is $\text{cov}(u_i, u_j) = E\{[u_i - E(u_i)][u_j - E(u_j)]\} = E(u_i u_j) = 0$

30 http://www.usda.gov/wps/portal/usdahome

31 Expenditures on public stock holding, domestic food aid, relief from natural disasters has been removed.

32 Ygb, ygs,yenv and ydc are the cross products of output with total green box subsidies, general services, environmental services and decoupled payments respectively.

Dcwagecp, Dcint) are obtained by multiplying the log values of subsidies to log values of input prices.

Translog Cost Specification with regard to Total GB Subsidies

The parameter estimates for the translog cost specification with total GB are given in Table 26. The coefficient of interest rate, quadratic term of GB, interaction effect of output with fertilizer price, interest rate, and interaction effect of GB with wages, fertilizer price and few cross price terms are found to be significant at 5 per cent . The results indicate that cost decreases as interest increases, which may be attributed to the fact that farmers use GB subsidies for investing, consequently demand for borrowed money decreases. Considering only the direct effect of GB, the results depict that every 1 per cent increase in GB reduces the elasticity of cost with respect to GB by 0.16 units. The interaction effect of GB with fertilizer price indicates that with every 1 per cent increase in GB subsidies the share of fertilizer in total cost increases by 0.484 units. The interaction effect of GB with wages (Gwagecp) shows that share of labour cost decreases by 0.278 units due to 1 per cent increase in GB subsidies. Thus due to GB, wage share decreases in total cost while fertilizer share increases. If there is any increase in fertilizer price, wage share in total cost further reduces as the interaction term of labour and fertilizer price is negative and significant.

The reduction of cost may be attributed to the fact that different kinds of subsidies given under the variety of programmes might be reinforcing each other to reduce the cost of production. Second, GB subsidies reduce the cost of production by influencing negatively factor share cost of labour in total cost. However, it increases the factor share of fertilizer cost in total cost. It might be inferred from these results that GB subsidies have labour reducing effects. The results also indicate movement towards capital intensive agriculture due to GB subsidies.

The labour reducing effect of GB seems logical when the nature of US technical change and research and extension services are considered. Technical change in US agriculture has been labour-saving since agricultural labour is a relatively scarce. Hayami and Ruttan's (1985) induced innovation hypothesis predicts that technologies will be developed that conserve on relatively scarce factors of production. GB subsidies seem to be an important instrument in the development of labour saving technology in the US.

Table 26 Translog Cost Function With GB Subsidies.

lncost	Coef.	z
lny	25.61	0.20
Lnldpcp	-103.40	-1.22
Lnlbpcp	50.80	1.07
Lnint	-36.62	-2.17*
Lnfertp	0.39	0.27
lngbdef	-3.69	-0.77
gddef	-0.16	-8.32*
ysq	-1.60	-0.23
Ywagecp	-2.31	-1.01
Yrentcp	4.67	1.16
Yfertcp	0.59	3.06*
Yint	1.95	1.98*
Ygb	.07	0.35
Grentcp	-.09	-1.08
Gwagecp	-.27	-2.95*
Gint	-.07	-1.10
Gfertcp	.48	2.27*
Rentint	-5.27	-3.69*
rentfertcp	-1.33	-1.05
Rentwages	10.68	2.02*
Wageint	3.4	2.72*
Wagefertcp	-14.42	-5.21*
Intfertcp	0.91	0.98
_conss	-2159	1.92*
years		

** indicates statistically significant at 5% level of significance*

Existing literature explains various ways in which GB subsidies reduce cost. For instance, there are intuitive reasons to expect agricultural research and extension as well as inspection services (sanitary, phytosanitary, grading, certification and consumer protection) to reduce production and transaction costs. Similarly, Structural adjustment payments might help induce high-cost parcels of land and high-cost producers to exit the agricultural sector, reducing industry-wide average cost.

On the basis of above discussion, it is easy to infer that removal of subsidies may be beneficial to agriculture labour in the US. There is convincing statistical evidence which confirms the

concentration of existing farm programme payments among large producers and agribusiness. This is well-recognized in reports by ERS. e.g., a report in the February 2005 issue of the ERS publication *Amber Waves* on growing farm size and the distribution of commodity program payments.

(http://www.ers.usda.gov/AmberWaves/February05/DataFeature/).

Translog Cost Specification with regard to General Services

The parameter estimates for the translog cost specification with subsidies on general services are given in Table 27. It can be seen that subsidies on general services reduce costs of all factors of production. This cost reduction may be attributed to the various programmes under general services which have production enhancing and cost reducing effects. For instance, agriculture research service reduces cost of production by developing new techniques and methods for protection and storage of agricultural production. Subsidies under public research and extension expenditures might also enhance agricultural productivity. Higher productivity raises output and causes prices to fall, but does not impoverish farmers because the productivity gains also lower their costs of production. (David, Kaukab, and Bonilla 2002).

Table 27 Translog Cost Function With Subsidies On General Services.

lncost	Coef.	z
lny	-27.16	-0.50
Lnldpcp	-93.16	-2.00*
Lnlbpcp	35.81	0.95
Lnint	-35.77	-3.01*
Lnfertp	-1.46	-1.12
lngsdef	-3.46	-1.58
gsdefs	-0.11	-2.61*
ysq	0.90	0.30
Ywagecp	-1.63	-0.91
Yrentcp	4.14	1.91
Yfertcp	0.65	4.27*
Yint	1.90	2.21*
Ygs	0.05	0.52
Gsrentcp	-0.12	-2.42*
lncost	Coef.	z
Gswagecp	-0.30	-5.74*

Gsint	-0.18	-2.35*
Gsfertcp	0.55	4.04*
Rentint	-4.73	-2.88*
rentfertcp	-0.81	-0.75
Rentwages	8.53	3.12*
Wageint	6.12	3.35*
Wagefertcp	-14.53	-8.94*
Intfertcp	0.18	0.13
_conss	-1601.92	-3.27*
years		

Translog Cost Specification with regard to Environmental Services

The results for translog cost function with subsidies for environmental programmes are presented in Table 28. The coefficient of interest rate, squared term of subsidies on environmental programmes (env), interaction effect of output with fertilizer price (fp) and interest rate and interaction effect of environment with rent, wage and fertilizer price along with some cross price terms are found to be significant at 5 per cent. The result implies that there is a negative relationship between cost and interest, which may be due to lower borrowing in view of increased interest. The effect of environmental subsidies on total cost is negative.

GB programmes such as the Environmental Quality Incentives Program *(*EQIP) can also affect costs through the introduction of more environmentally benign technologies which might not have been adopted in the absence of government cost-share programmes. If new technologies are adopted on a large scale, they can potentially affect production, prices, and trade (ERS 1998). This is in keeping with the findings of this study which indicates that there is significant cost reducing effect of subsidies on environmental programmes.

Table 28 Translog Cost Function With Environmental Subsidies.

lncost	Coef.	z
lny	-1.37	-0.01
Lnldpcp	-75.89	-1.04
Lnlbpcp	3.98	0.09
Lnint	-31.36	-2.64*
Lnfertp	-0.81	-0.50
Env	0.85	0.30
Envdefs	-0.16	-3.41*
ysq	-0.004	-0.0
Ywagecp	-0.17	-0.08
Yrentcp	3.30	0.95
Yfertcp	0.34	3.67*
Yint	1.68	2.80
Ygb	-0.12	-0.99
Envrentcp	-0.20	-2.21*
Envwagecp	-0.34	-5.32*
Envint	-0.16	-1.22
Envfertcp	0.44	2.22*
Rentint	-4.93	-3.72*
rentfertcp	1.015	1.21
Rentwages	3.35	1.37
Wageint	4.63	1.69
Wagefertcp	-10.17	-5.44*
Intfertcp	0.46	0.34
_conss	-1927.91	-1.86

Translog Cost Specification with regard to Decoupled Payments

Table 29 Translog Cost Function With Decoupled Payments.

lncost	Coef.	z
lny	109.43	2.81*
Lnldpcp	-9.04	-0.11
Lnlbpcp	40.58	1.70
Lnint	-37.11	-0.50
Lnfertp	-1.65	-0.71
Lndecoudef	-8.21	1.20
decoups	-0.046	-8.54*
ysq	-5.39	-3.51
Ywagecp	-2.00	-1.79
Yrentcp	0.29	0.08
Yfertcp	0.86	3.78*
Yint	1.41	0.45
ydc	0.23	-0.03
Dcrentcp	-0.0028	-3.66*
Dcwagecp	-0.28	-2.59*
Dcint	-0.30	7.14*
Dcfertcp	0.79	0.22
Rentint	0.42	-15.17*
Rentfertcp	-3.37	3.13*
Rentwages	9.72	4.05*
Wageint	7.67	-8.58*
Wagefertcp	-15.39	0.90
Intfertcp	1.76	0.83
_conss	-3105.61	-6.24
Years		

The result for translog cost function with subsidies for decoupled payments (DP) are given in Table 29. The coefficient of output, quadratic term of decoupled payments, quadratic term of output, interaction effect of output with wage, fertilizer price and interest rate and interaction effect of decoupled payments with rent, wage and fertilizer price along with some cross price terms are found to be significant at 5 per cent level of significance. There is a negative effect on costs due to decoupled payments. Increase in decoupled payments has a negative effect on

interest rate due to increased cash flow to the farmers and resultant decrease in demand for borrowed resources. The decreasing interest rate further leads to labour reduction. Increased cost share of fertilizers in total cost is also apparent with decoupled payments due to indirect effects arising from reduced risk, enhanced cash flow, or increased producer wealth. Furthermore, government payments to field crop farmers in the US in the form of PFCs and MLAs stimulate higher production because some fixed costs are covered. This induces farmers to stay on the land because of reduction in risks of production and increased expectations for more support in the future (de Gorter 2001). Market signals are masked, with the result that producer decisions are made in response to the decoupled payments rather than to the market (Grey, Clark, Shih and Associates, Limited, 2006). The result of present study also indicates cost reducing effect of DC.

The translog cost function explicitly depicts the cost decreasing effect of subsidies provided under GB. The result indicates that subsidies have a fertilizer augmenting effect and labour reducing effect. The inference from the above discussion is that GB subsidies are cost reducing and therefore refute the premise that GB subsidies are not trade distorting and production enhancing.

Crop-Wise Results

GB subsidies might have differential production effects on different crops. In order to analyse this, a Cobb Douglas Cost function is used to estimate the impact of GB subsidies on the cost of production of five major crops. The crops used in our analysis are soybean, corn, cotton, rice and wheat. These products constitute around 81 per cent of total crop production in US. The three most important crops in the US are currently corn, soybeans and wheat. These three crops account for about 87 per cent of acreage for the eight major US field crops and over 60 per cent of acreage for all US field crops. Rice acreage has risen from 650 thousand ha in 1960 to about 1.4 million ha in 2005, however, it remains small compared to corn, soybeans or wheat. Since it is not possible to estimate the share of GB expenditures with respect to each crop, it is assumed that each crop benefits equally from all categories of GB expenditures. For example if infrastructure subsidies are granted production of all crops will benefit equally. Therefore the effect of total GB expenditures on cost of production of each crop is estimated.

Variables and Data Sources

The model estimated is:

$$C(q; gb ; wL,wK,wM) = h(q) * c(wL,wK,wM)$$

Where C is cost; q is output; gb is GB expenditures/general services expenditures/ environment services/ decoupled payments; wL is wages paid to agricultural labour; wK is cost of capital and wM is cost of inputs like fertilizers.

Constant returns to scale are assumed. Using data from 1975 to 2004, the cost function is estimated using a time-series analysis. Cochrane Orcutt AR (1) regressions are estimated. Separate equations are estimated using log of deflated GB expenditures (lngbdef), log of deflated general services (lngsdef), log of deflated environment services (lnenvr) and log of deflated decoupled payments (lndecoud)[33].

The variables used are as follows:

1. Land: Data from USDA on land under cultivation in different crops deflated by land price series.
2. Labour Prices: Real wage rates collected from *World Development Indicators, 2006*.
3. Capital price: Number of tractors (also used by Coelli and Prasada Rao 2003) and their imported price has been used for capital price. Annualized flows of capital are used.
4. Fertilizer prices: Data collected from USDA at Constant price s.
5. GB Expenditures: Data from WTO notifications. To arrive at constant price series, GDP implicit deflators have been used.

Empirical Results

Studies show that under the existing US policy, the cost of producing major crops has been much higher than the prices realized for them. In the year 2001, market prices were 23 per cent below the cost of production for corn, 48 per cent for wheat, 32 per cent for soybean, 52 per cent for cotton, and 45 per cent for rice(Ray et al, 2003).In 2001 US had a significant share in world exports in these commodities which is as high as 35 per cent in cotton, more than 20 per cent in wheat and around 10 per cent in rice.

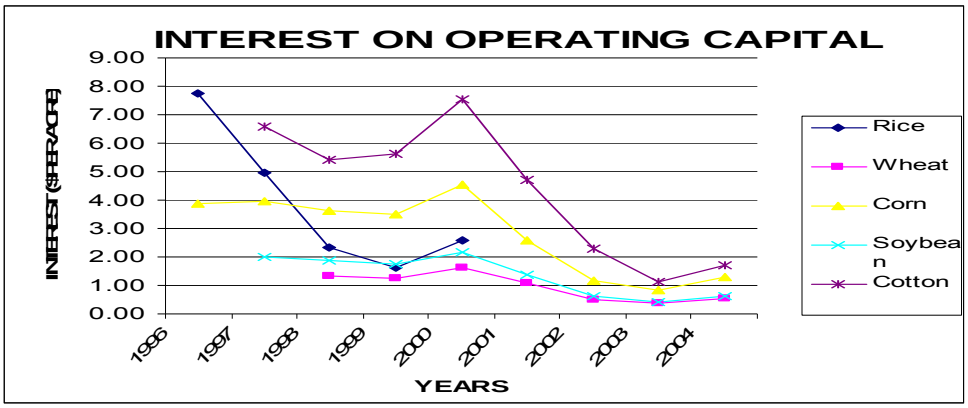
[33] High correlation coefficient was found between lngsdef and lnenvr. To check omitted variable bias an equation including all three components of GB expenditures was run and significant coefficient were found for lngsdef and lndecoud

According to the Farm Bill 2002 commodity programme, 'farmers who participated in the wheat, corn, barley, grain sorghum, oats, upland cotton, and rice programs in any one of the years 1991–5 could enter into 7-year production flexibility contract for 1996–2002 during a one-time enrollment period.' This implies that the subsidies given earlier continue. Direct payments are available for eligible producers of wheat, corn, barley, grain, sorghums, oats, upland cotton and rice. Allocation of these payment levels are: 26.26 per cent for wheat, 46.22 per cent for corn, 11.63 per cent for upland cotton and 8.47 per cent for rice. Payment rates specified are $0.52 per bu for wheat, $ 0.28 per bu for corn, $0.44 per bu for soybean and $2.35 per cwt for rice. Loan rates also differ across crops and are provided on a per-unit value to farmers via commodity secured loans. Loan rates for 2002–03 were fixed at $2.80 per bu for wheat, $1.98 per bu for corn, $6.50 per cwt for rice and $5.00 per bu for soybean and $0.52 per lb for upland cotton

This makes it important to carry out crop-wise estimates of effects of GB expenditures and its components on crop-wise cost of production. However, since the number of available observations is only 30, these estimates may not have the desired robustness.

A cursory look at the data gives some important insights. Over time, it is found that rate of interest on operating capital in terms of dollars per acre for different crops decline in the period 1996 to 1999 and between 2000 and 2003 (Figure 4).

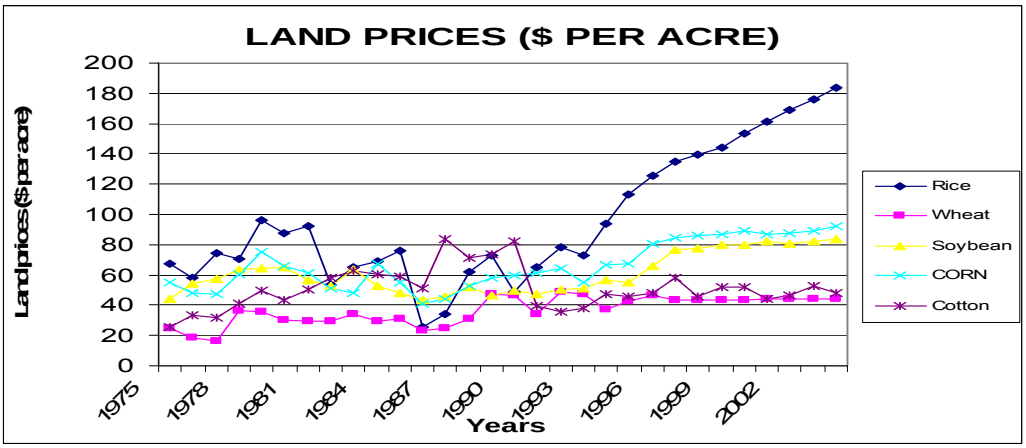
Figure 4 Interest on Operating Capital .



Source- USDA Website

Benefits that accrue to cropland enrolled in US farm are mainly capitalized into land values. It is found that land prices for rice have increased substantially since the latter half of the 1990s.This might be linked to the fact that the direct payments for rice are relatively high.

Figure 5 Land Prices (US$ per ha).



Source- USDA Website

Wheat

The results with respect to wheat presented in Table 30 show that GB expenditures have reduced the cost of production of wheat by 5.0 per cent. With respect to general services and environmental services the reduction of cost is around 6 per cent and 7 per cent respectively. However, the effect of decoupled payments is not found to be statistically significant.

Table 30 Wheat.

Variable	**Coefficient (t-values)**	**Coefficient (t-values)**	**Coefficient (t-values)**	**Coefficient (t-values)**
Constant	-1.85 (-0.80)	-1.84 (-0.79)	-1.85 (-0.80)	-2.28 (-0.88)
Lny	0.12 (0.99)	0.12 (1.01)	0.12 (0.99)	0.18 (1.38)
lnldp	0.25 (3.94)*	0.25 (3.96)*	0.25 (3.94)*	0.29 (4.92)*
lnlbp	0.31 (4.43)*	0.31 (4.37)*	0.31 (4.39) *	0.31 (3.29)*
lntracp	0.29 (2.05)*	0.29 (2.04)*	0.29 (2.08)*	0.19 (1.62)
lngbdef	-0.05 (-2.46)*	--	--	--
lngsdef		-0.06 (-2.46)*	--	--
lnenvr		--	-0.07 (-2.57)*	--
lndecoud		--	--	-0.03 (-0.84)
F (6,23)	40137.43	39187.59	39886.54	36071.06
Prob > f	0.00	0.00	0.00	0.00
R-squared	0.88	0.88	0.88	0.88

** depicts that the result is statistically significant*

Corn

The results with respect to corn presented in Table 31 show that GB expenditures reduce the cost of production of corn by 7 per cent and are found to be statistically significant. The other three components of GB also have significant impact on cost of production of corn. Expenditure on general services reduces cost of production by 8 per cent, environment services by 10 per cent and decoupled payments by 8 per cent. Land prices are not found to add as significantly to cost of production as in the case of wheat.

Table 31 Corn.

Variable	**Coefficient (t-values)**	**Coefficient (t-values)**	**Coefficient (t-values)**	**Coefficient (t-values)**
Constant	0.51 (0.41)	0.61 (0.62)	0.56 (0.57)	0.61 (0.62)
Lny	0.08 (2.73)*	0.08 (0.98)	0.08 (3.02)*	0.08 (2.98)*
lnldp	0.16 (1.96)*	0.15 (2.30)*	0.14 (2.24)*	0.15 (2.30)*
lnlbp	0.23 (0.78)	0.14 (0.68)	0.14 (0.67)	0.14 (0.68)
lntracp	0.25 (3.61)*	0.25 (3.74)*	0.25 (3.81)*	0.25 (3.74)*
lngbdef	**-0.07 (-3.26)***	--	--	--
lngsdef	--	**-0.08 (-3.68)***		--
lnenvr	---	--	**-0.10 (-3.75)***	--
lndecoud	--	--	--	**-0.08 (-3.68)***
f (5,23)	17.19	17.95	18.27	10.34
Prob > f	0.00	0.00	0.00	0.00
R-squared	0.78	0.79	0.79	0.69

* depicts that the result is statistically significant

Rice

The results with respect to rice presented in Table 32 show that GB expenditures have considerable impact on cost of production of rice, which goes down by 5 per cent. The impact of general services and environment services on lowering cost of production are found to be 6 per cent and 8 per cent respectively. However, impact of decoupled payments is not found to be statistically significant.

Table 32 Rice

Variable	**Coefficient (t-values)**	**Coefficient (t-values)**	**Coefficient (t-values)**	**Coefficient (t-values)**
constant	1.97 (1.95)*	1.91 (1.90)*	1.85 (1.85)	3.07 (2.86)*
lny	0.04 (0.81)	0.40 (0.77)	0.03 (0.74)	0.07 (1.81)
lnldp	0.05 (1.56)	0.04 (1.35)	0.04 (1.18)	0.12 (5.90)*
lnlbp	0.31 (3.38)*	0.31 (3.52)*	0.31 (3.67)*	0.12 (0.46)
lntracp	0.29 (4.21)*	0.30 (4.69) *	0.32 (4.95)*	0.10 (1.64)
lngbdef	**-0.05 (-2.26)***	--		--
lngsdef	--	**-0.06 (-2.40)***		
lnenvr	--		**-0.08 (-2.52)***	
lndecoud	--	--	--	
f (6,23)	49186.15	52922.20	54427.36	
Prob > f	0.00	0.00	0.00	
R-squared	0.88	0.90	0.91	

** depicts that the result is statistically significant*

Soybean

The results for impact of GB expenditures and its components on soybean are reported in Table 33. With respect to soybean it is found that GB expenditures reduce cost of production by 1 per cent. The estimate is statistically not very significant. Expenditure on general services, environment services, and decoupled payments reduces cost of production of soybean by 1 per cent. Land prices seem particularly important for the crop.

Table 33 Soybean

Variable	**Coefficient (t-values)**	**Coefficient (t-values)**	**Coefficient (t-values)**	**Coefficient (t-values)**
Constant	--	--	--	--
Lny	0.06 (1.39)	0.06 (1.40)	0.06 (1.40)	0.08 (1.65)
lnldp	0.37 (5.59)*	0.37 (5.62)*	0.37 (5.59)*	0.40 (5.69)*
lnlbp	0.28 (1.65)	0.28 (1.66)	0.28 (1.65)	0.26 (1.64)
lntracp	0.00 (0.03)	0.00 (0.03)	0.00 (0.03)	0.00 (0.01)
lngbdef	**-0.01 (-1.70)***	--	--	--
lngsdef	--	**-0.01 (-1.85)***	--	--
jnenvr	--		**-0.01 (-1.69)***	--
Lndecoud	--		--	**-0.01 (-1.90)***
f (5,24)	1875.31	168.78	847.51	332.52
Prob > f	0.00	0.00	0.00	0.00
R-squared	0.45	0.45	0.45	0.45

** depicts that the result is statistically significant*

Cotton

The results for cotton presented in Table 34 show that GB expenditures reduce cost of production by 1 per cent. Impact of expenditures on general services is not found to be statistically significant. Both decoupled payments and environment services are found to reduce cost of production by 2 per cent. Land and labour prices are found to have significant impact.

Table 34 Cotton

Variable	**Coefficient (t-values)**	**Coefficient (t-values)**	**Coefficient (t-values)**	**Coefficient (t-values)**
Constant	2.08 (3.86)*	2.07 (2.94)*	2.09 (3.26)*	2.08 (2.95)*
lny	0.80 (2.76)*	0.80 (2.19)*	0.84 (2.35)*	0.80 (2.19)*
lnldp	0.25 (10.75)*	0.25 (7.39)*	0.24 (7.87)*	0.25 (7.39)*
lnlbp	0.30 (5.20)*	0.30 (6.06)*	0.35 (7.16)*	0.30 (6.07)*
lntracp	0.12 (2.17)*	0.12(2.47)*	0.10(2.60)*	0.12 (2.46)*
lngbdef	**-0.01 (-2.15)***		--	--
lngsdef	--	**-0.001 (-0.12)**	--	--
lnenvr	--	--	--	**-0.02 (-1.90)***
lndecoud	--	--	**-0.02 (-2.75)***	--
f (6,23)	93872.91	82.49	128.09	82.59
Prob > f	0.00	0.00	0.00	0.00
R-squared	0.94	0.94	0.96	0.94

** depicts that the result is statistically significant*

Conclusion: Summarizing the results of the Empirical Analysis

This section summarizes the main findings of the empirical analysis carried out in the paper thus far.

To estimate the impact of GB expenditures on agricultural productivity and cost efficiency DEA has been used. Initially the total factor productivity growth for 27 countries during the period 1995–2000 is estimated using Malmquist indices. DEA analysis finds that there has been an increase in TFP in all the three high GB countries, with Japan experiencing the highest rise. Countries such as Korea, Switzerland and Thailand also experience a rise in their productivity with GB expenditures.

Cost efficiencies are also calculated using the input oriented DEA analysis. This analysis finds that GB expenditure in Switzerland(30%) and Japan(24%) has the highest relative impact on cost efficiency. This is a plausible result since food aid component in both the cases is very small. US and EU also experience cost reductions of around 15 per cent to 17 per cent respectively, while Canada and Argentina also show significant cost reductions. Further it can also be seen that with GB expenditure most of the developing countries become less cost efficient since the frontier shifts inwards with increasing efficiency in developed countries.

Since the DEA analysis is non parametric, the paper also uses a parametric approach in which the Translog cost function is estimated to calculate the direct and interaction effects that GB subsides and its components may have on the cost of production in the US. The estimation finds that a 100 per cent increase in GB support leads to 16 per cent reduction in cost of production. The following results are obtained regarding the impact of certain components of GB support: (i) 100 per cent increase in general services component leads to 11 per cent reduction in cost of production; (ii) 100 per cent increase in environmental programme support under GB leads to 16 per cent reduction in cost of production; (iii) 100 per cent increase in decoupled income support leads to 4.6 per cent reduction in costs.

In order to estimate the impact of the reduction in cost of production as a result of GB expenditure on trade and production, the results of the DEA analysis on cost efficiencies are plugged into the CGE model. Simulating for increase in cost of production on account of

elimination of GB support, the following results emerge. Elimination of GB subsidies reduces output in the EU, US, Canada and Switzerland in the range of 2.23 to 7.74 per cent. The reduction of output is highest in Canada and Switzerland. This could be due to the fact that technical efficiency in these countries is not high and hence the removal of GB stands to affect their productivity the most. Among these countries the decline in output is the lowest in the US. This might be due to the fact that in the US a large amount of GB is directed towards food aid. Removal of GB reduces exports from developed countries such as US, EU, Canada, Japan and Switzerland in the range of 39 to 77 per cent while it increases exports from developing countries from 40 to 80 per cent. In terms of agricultural employment the simulation also shows that there might be a positive impact on unskilled agricultural employment in developing countries with an increase in wages. It could be inferred from this that the reduction of GB subsidies would have a poverty alleviating effect on rural poor in developing countries.

Finally in order to estimate the differential production effects of GB subsidies and its various categories such as general services, environmental payments and decoupled payments on different crops the paper uses a Cobb Douglas Cost function. This estimates the impact of these payments on the cost of production of five major crops (soybean, corn, cotton, rice and wheat) constituting 81 per cent of total crop production in the US. . The results depict that GB expenditure as a whole has the maximum impact on the cost of corn (7 per cent) and wheat (5 per cent) followed by rice (5 per cent) and cotton (1 per cent). Reduction in cost of production due to general services is once again highest for corn (8 per cent), wheat (6 per cent) and rice (6 per cent), followed by soybean (1 per cent). Environmental services reduce the cost of production of corn by 10 per cent, wheat by 7 per cent, rice by 8 per cent and Soybean by 1 per cent. Though decoupled payments reduce the cost of production of all the crops considered, the results are significant only for corn (8 per cent) and soybean (1 per cent).

V. REVIEW AND CLARIFICATION OF GB CRITERIA: PROGRESS IN NEGOTIATIONS

Under the Agreement on Agriculture, Green Box domestic support is not subject to reduction commitments. Further, rules and disciplines on GB are not as stringent as those on amber box support. Unlike amber box support, which was subject to reduction commitments under the AoA, there is no reduction commitment for GB support. Countries cannot provide amber box support beyond a prescribed ceiling. However, as there is no upper bound for GB support, countries can provide any amount under this support subject to meeting the criteria specified in Annex 2 of AoA.

In the context of the findings of the paper thus far, it is pertinent to look at the current developments in the GB negotiations as also the proposals put forward by the different members on reviewing the GB criteria. As per paragraph 16 of the July 2004 Framework, the WTO members have been mandated to review and clarify the GB criteria to ensure that the trade or production effects are minimal or absent. This chapter, after setting out the mandate for review as specified in the July Framework and the Hong Kong Declaration, very briefly specifies some of the proposals put forth by different members.

Mandate for review and clarification of GB criteria: The July Framework and the Hong Kong Declaration

On the issue of GB support, different members vary in their views. For instance while the G-20, Canada and Australia argue that some of the criteria for GB spending need to be revised to minimize distortive impacts, others such as the US and the EU argue against making substantial changes (ICTSD, 2006) .. It is in the context of this debate that the July framework put forth a mandate for review and clarification of the GB criteria (Paragraph 16 of this Framework (Annex A of WT/L/579)).The modalities of clarifying the GB criteria have been left to the negotiations. Paragraph 5 of the Hong Kong Ministerial Declaration states that GB criteria will be reviewed in line with paragraph 16 of the Framework, *inter alia*, to ensure that programmes of developing country Members that cause not more than minimal trade-distortion are effectively covered. What has to be noted here is that while the July framework made no specific mention of developing countries this declaration specifically does so.

On the basis of discussions held so far, it may be concluded that at a broad level WTO Members appear to be pursuing two objectives in the process of review and clarification of GB

criteria: (i) making the eligibility criteria for developed countries more restrictive; and (ii) clarifying/ inserting additional criteria for covering programmes of developing countries that cause no or minimal trade-distortions. While there appears to be considerable openness among Members to better tailor the GB criteria to meet the realities of developing country agriculture, there appears to be some resistance to altering the criteria for making it more restrictive.

Paragraph 16 of the July Framework also specifies that the review and clarification will need to ensure that the basic concepts, principles and effectiveness of the Green Box remain and take due account of non-trade concerns. Some developed countries are of the view that the current criteria are adequate, and might even need to be made more flexible to take better account of non-trade concerns such as environmental protection and animal welfare. These countries are concerned that any change to the existing green box provisions might have the effect of undermining their reforms. Thus, there is, on the one side, a firm resistance to anything that is seen as departing from the existing disciplines while there is, on the other, an enduring sense that more could be done to review the Green Box[34].

Proposals have been made by different WTO members on the different categories of GB support such as general services, public stock holding for security purposes, domestic food aid, direct payments to producers, decoupled income support, income insurance and safety net programmes, natural disaster relief payments, structural adjustment assistance through retirement programmes and investment aids and regional assistance programmes[35]. Box 4 very briefly sets out some of the negotiating proposals.

[34] Draft Possible Modalities on Agriculture, JOB(U6)/199 plus corr 1 changes, 22 June 2006

[35] Appendix 3 gives a detailed explanation of the proposals in each of these categories.

Box 4 Various Negotiating Proposals on GB Subsidies[36]

Proposals which seek flexibility for developing countries

- Extend the coverage of general services to include categories such as agrarian land and institutional reform, including related services such as settlement programmes and also services related to developing country proposals on food, livelihood security, rural development and infrastructure provision.
- Unambiguous clarification that the acquisition costs of stocks of foodstuffs would be accommodated within the 10 per cent *de minimis* allowance for developing countries.
- Amend footnotes 5 & 6 (related to paragraphs on stockholding for food security purposes and domestic food aid) to cover the acquisition of foodstuffs at subsidized prices when generally procured from low-income or resource-poor producers in developing countries with the objective of fighting hunger and rural poverty.
- In terms of payments under regional assistance programmes the negotiating proposals seek to exempt developing countries from the requirement that a disadvantaged region must constitute a clearly designated contiguous geographical area with a definable economic and administrative identity

Proposals which seek strengthening of disciplines

- Various negotiating suggestions have been put forth regarding direct payments such that they should be delinked from production levels, including input levels therein; they should be based on activities in a ***fixed and unchanging historical base period***; amend the last sentence of paragraph 5 thereby requiring that direct payments exempt from reduction commitments conform to (a revised) criterion 6(a)[37] in addition to criteria 6(b) through (e) of paragraph 6, delete the last sentence of paragraph 5, thereby making paragraphs 6 to 13 the exhaustive list for possible direct payment support.
- In respect of decoupled income support changes have been suggested to constrain some of the eligibility criteria for this support. It has been suggested that eligibility for such support be determined by criteria of **low** level of income, landholding and production in a notified and unchanging base period. Some countries have suggested adding the criteria that land, labour or any other factor of production should not be required to be in 'agricultural use' in order to receive payments. It has also been proposed that an additional sub-paragraph (f) be added to paragraph 6 to reflect that direct payments under paragraph 6 should not be made along with Amber Box or Blue Box support if the total value of support exceeds a certain percentage of the annual value of production of a given product.
- Negotiating proposals have also been made on the eligibility criteria and the payments for income insurance and safety net programmes as also for natural disaster relief programmes.
- In terms of structural adjustment assistance while no proposals have yet been made on resource/producer retirement programmes, for assistance programmes through investment aids it has been proposed that structural disadvantages must be clearly defined in the context of government programmes for reprivatization of agricultural land.

Assessment of GB proposals

It may be useful to briefly discuss the specific concerns arising from the implementation of the Agreement on Agriculture, which the various proposals on GB seek to address. Under provisions of paragraph 6(a) eligibility for decoupled income support is required to be based on clearly-defined criteria in a 'defined and fixed base period'. According to the G-20 proposal, this has been interpreted by some WTO Members to fix the base period only for specific time intervals, which are subsequently updated. This reinforces the farmers' expectations, thereby influencing their future production decisions. Overall, updating the base year provides farmers

[36] Appendix 3 provides further details on the negotiating proposals on GB subsidies.

[37] Criteria 6(a) is described in detail on page 96 in paragraph 1.

with incentives to keep production levels high. Stipulating base periods which are fixed **and unchanging** could remove the incentive for the farmers to maintain high levels of production so that they become eligible for higher support in case the base period is updated in future. The proposals seeking to insert 'a defined, fixed and unchanging historical base period' in paragraph 5(a) and 'unchanging historical base period' in paragraph 6(a) appear to have been made in order to address this problem of updating base periods.

Another issue of concern relates to the fact that subsidies in general are concentrated in the hands of very few entities. Among subsidy recipients in the US, large farms collect almost all the money. Nationwide, ten per cent of the biggest (and often most profitable) subsidized crop producers collected 72 per cent of all subsidies amounting to $104 billion over 10 years. Recipients in the top 10 per cent averaged $33,283 in annual payments between 1995 and 2004. The bottom 80 per cent of the recipients saw only $721 on average per year.[38] In order to address the issue of concentration of decoupled income support in a few entities and to avoid payments being received by big farmers, G-20 has proposed that eligibility for decoupled income support should be determined by criteria of low levels of income, landholding and production[39]. This proposal could have far-reaching effects. First, it would restrict the eligibility for receiving decoupled income support to producers, thereby excluding landowners who are not producers. Second, in order to become eligible for receiving decoupled income support, the producer must **simultaneously** satisfy the three criteria of low income, low production and small landholding.

The proposed change in criteria could ensure that decoupled income support is not available to agri-business and rich farmers. The benefits of GB would be mainly available to small and poor farmers. However, what may be a low level of income in a developed country may represent high income in a developing country. Similarly, a small land holding in a country with extensive agriculture may not be considered small in a country practicing intensive farming. For the proposal to be more meaningful, it may therefore be necessary to specify the indicators for the 'low level'. To illustrate, income could be categorized as low, if it is 15 per

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38 Environmental Working Group's Farm Subsidy Database accessible at http://www.ewg.org/farm/region.php?fips=00000 visited on 18 May 2006 ; (G20/DS/Greenbox FINAL 02/06/05)

39 In fact a survey carried out in 2004 by the Program on International Policy Attitudes finds that more than three-quarters of Americans (and 81 per cent of those in farm states) are in favour of the US government giving subsidies to small farmeres who own less than 500 acres, but only 31 per cent (and the same proportion in farm states) are in favour of subsidies for large farming businesses.

cent below the per capita income for the country. Similar indicators could be proposed for low production and low landholding.

Other proposals also seek to address the incentive for increasing production which arises when coupled support programmes(Amber or Blue Box) are implemented in combination with GB direct payments on the same product. The World Bank has pointed out that 'the co-existence of coupled and decoupled programmes means that incentives to overproduce remain'[40]. In the EU, member states have the option to keep part of the payment linked to crop and livestock production. Up to 25 per cent of the payments for arable crops, and 50 to 100 per cent of animal payments may remain linked, or coupled. France and Spain have both made use of this option in the case of area payments. Cereal farmers who stop production, or shift to livestock production, for example, receive only 75 per cent of their previous payments, and have to cover the costs of keeping the land in good condition. If they continue production, however, they receive 100 per cent of the payments, plus the income from marketing their crops. The second option would obviously be attractive if the variable costs of production were reasonably compensated by crop prices[41]. This is particularly likely in France, Europe's largest and arguably most competitive cereal producer. In the US countercyclical payments are administered in conjunction with direct payments. As a result, they work inversely with market prices—payments are large when market prices are low and payments are small or non-existent when market prices are high(Somers,2005). To address this issue and to avoid magnifying incentives for overproduction, it has been proposed that GB support should not be allowed in combination with other trade-distorting support.

Suggestions for further proposals

While various proposals have been made by WTO members for strengthening disciplines on GB support, two specific areas remain where additional proposals would be required. These relate to decoupled payments granted for planting flexibilities and improved disciplines on general services and environment programmes. Exclusion of certain crops for determining eligibility to receive decoupled payments provide an incentive to channel production towards crops that are eligible for support. The WTO dispute panel in *US, Cotton Subsidies* has ruled

[40]Aksoy, M Ataman and John C. Beghin(ed), 'Global Agricultural Trade and Developing Countries',World Bank Report 2005

[41] Actionaid, Caritas Internationalis, CIDSE and Oxfam, (2005) 'Green but not Not Clean: Why a Comprehensive Review of Green Box Subsidies is Necessary', Joint NGO Briefing Paper, November 2005.

that planting flexibility limitations relate to the type of production undertaken by the producer after the base period and hence do not fully conform to the requirements of paragraph 6(b) of Annex 2 (WT/DS267/R). In the 2002 Farm Act the planting flexibility provisions are the same as those in the 1996 Act, except that wild rice will be treated at par with fruit/vegetable. Thus violation of requirements of paragraph 6(b) of Annex 2 would continue even under the 2002 Farm Act.

The finding on planting flexibility has important implications not only for direct payments in US but also for EU's single payment scheme under CAP reforms of 2003. This scheme has been claimed to be decoupled, and therefore it is possible that EC would claim eligibility for classifying it under GB. However, the single payment scheme may be used for any agricultural activity except for fruit, vegetables and table potatoes. The scheme may, therefore, not be in conformity with the findings of the WTO dispute panel.

The empirical analysis carried out in the previous chapters of this paper suggests that GB support for general services and environment programmes have significant effects on production. However, the negotiating proposals made so far do not seek strengthening of eligibility criteria for receiving payments under these two categories. Countries could consider the following suggestions for making negotiating proposals:

(i) GB support for training services, extension and advisory services, inspection services and marketing and promotion services should be available only to resource poor or subsistence farmers.

(ii) GB support for environmental programmes should be available only to farmers with farm size holdings below a specified level.

By specifying the above criteria, big farmers and agri-business would not be eligible to receive these payments which in turn would limit the effects on production to an acceptable de minimis level.

Conclusion

This chapter looked at the mandate for review and clarification of GB criteria under the July Framework and the Hong Kong declaration. Various countries and coalitions have put forth different proposals for negotiations. These proposals are two fold—(1) clarifying and adding additional criteria for covering programmes of developing countries and (2) making the

eligibility criteria for developed countries more restrictive.To meet these objectives proposals have recommended that the base period for determining the subsidy amounts be fixed, historical and unchanging. Further direct payments are to be made only to producers with low income, low production and small landholdings. In addition to the current proposals, this paper has advanced two additional ideas. They relate to strengthening the eligibility criteria for (1) general services and (2)environment payments.

VI. CONCLUSIONS

The Uruguay Round Agreement on Agriculture aimed to reduce trade distorting subsidies, but measures which had no or minimal trade and production distorting effects were to be categorized as GB measures. These measures are exempt from reduction commitments and can even be increased without any financial limitation under the WTO. Secondary sources reveal that GB expenditures among the WTO members constituted 50.4 per cent of domestic support for developed members and 77.3 per cent for developing members during the period 1995–98 (Zhao et al (2004)). However the absolute amount of GB support provided by the developed countries far exceeds that provided by developing countries. It can also be seen that over this period there has been a change in farm support policies in the US, EU and Japan leading to a shift of domestic support from amber box to GB. Out of the US$ 96 billion dollars provided by the US, EU and Japan as GB support in 2001, about US$ 59 billion was granted for general services and various categories of direct payment[42].

Recent research shows that current GB subsidies do not meet the criteria of not or minimally distorting production and trade. And even the so called 'decoupled' programmes under GB do distort trade and production by affecting the wealth or risk behaviour of the producer or reducing costs of production or increasing productivity or acting as an insurance.

Using both computable general equilibrium modelling, the commonly used Global Trade Analysis Project (that is, GTAP), and Data Envelopment Analysis (DEA) this paper shows that GB subsidies do have significant distortive effects on trade and production. The estimates of GB subsidies used by this paper refer to the year 2000 or the nearest available data, and food aid for food security purposes, government procurement for stockholding and natural disaster relief have been removed to arrive at an adjusted GB subsidy estimate. This is because it is assumed that these subsidies are essentially designed to address the food security of lower income groups and should be provided for humanitarian reasons.

DEA shows that the reduction of GB subsidies increases the cost of production in relative terms in countries such as Japan, Switzerland, EU and the US by about 15–30 per cent.

[42] WTO notifications by the EC, US and Japan concerning their domestic support commitments.

Plugging these results in the GTAP model, significant trade and production effects are observed at a global level. Briefly, six broad inferences may be drawn from CGE analysis. First, agricultural production in developing countries will increase if GB subsidies are removed ; Second, there will be mild positive impact on global agricultural production; third, agricultural imports at a global level will decline; fourth, exports from developing countries will increase; fifth, agricultural wages in developing countries will rise, sixth; agricultural employment in developing countries as well as at the global level will rise and seventh agricultural production in net food importing countries will increase. All these effects combined will have poverty alleviating effect on rural people in developing and poor countries. Therefore, GB subsides given by developed countries would have production enhancing and trade distorting effects.

The paper shows that reduction of GB subsidies would leave global agricultural output virtually unchanged, registering a marginal increase of 0.13 per cent. This marginal increase in output indicates that the arguments on a decline in global production consequent to the reduction of subsidies may be incorrect. The largest decreases in output are seen in the EU, US, Canada, and Switzerland. The decline in output is lowest in the United States perhaps because its GB subsidies are mostly directed towards food aid. On the other hand, most developing countries increase their agricultural output, with the highest increases in Brazil, Chile, Thailand, Morocco, South Africa and Malaysia. Even the LDCs would find their agricultural output increasing by about 3 per cent. These results reveal the redistribution of global output in favour of competitive agricultural producers especially developing countries, in response to a reduction in trade distorting production of developed countries.

Furthermore, what is even more interesting is that while overall global trade goes down on account of decline in exports of EU, US, Canada etc, exports from developing countries and even the LDCs increase. Competitive developed countries such as Australia also gain by over 16 per cent in exports. Countries like US, EU, and Canada find their exports decline by about 40 per cent or more, whereas Switzerland and Japan would see their exports decline by over 60 per cent. Most developing countries including LDCs would find their exports go up by about 20 per cent.

Most countries would also move towards self sufficiency in agriculture as imports of all countries decline, with Switzerland, EU and Canada showing the highest decline of over 20 per

cent. The changing pattern of international trade with higher agricultural exports and output from developing countries including LDC's and lower exports and output from developed countries would also help to meet the development objectives of the Doha Work Programme.

Reduction of GB subsidies, through an expansion of agricultural exports and output in developing countries would have important positive livelihood effects. Agricultural employment would rise in almost all developing countries, while that in developed countries, especially those providing high GB subsidies would fall. The rise in agricultural employment of unskilled labour at the global level, the most poverty sensitive group, is found to be higher than the fall in employment of skilled labour. Least Developed countries also see their agricultural employment of skilled and unskilled labour go up. Wages also rise by about 1 per cent on an average in developing countries with the LDCs registering the highest increase. Even, the sum of the value (wage times quantity) of employment across all three sectors is also positive in all developing and least developed countries. Hence the positive effect of employment increase in the agriculture sector may not be outweighed by the negative effect of employment decrease in services and industry in absolute numbers. This implies that the poverty attenuating effects of the reduction of GB subsidies would be positive and significant. While overall emplyoment would be constant, there is a shift of emplyoment from other sectors towards agriculture, and poverty may be reduced as a result of the increase of value of emplyoment and not as a result of increasing emplyoment in agriculture only.

The significance of an increase in agricultural employment in terms of poverty alleviation far exceeds that of industrial or services liberalisation. In most developing countries a majority of the population would be engaged in agriculture either directly or indirectly, hence increase in agricultural employment would have significant poverty reducing effects. Therefore the positive effect of employment increase in the agriculture sector may not be outweighed by the negative effect of employment decrease in services and industry in absolute numbers. Overall employment will remain constant but the significant fact is that distribution in favour of agriculture will have significant poverty reducing effects. At any rate the distribution in favour of agriculture will have significant effects on the population just below the poverty line as shown by the increase in employment of unskilled labour and the increase in wages of this group.

A further estimation of effects of GB subsidies on cost of production in agriculture for US covering five major crops for which the data is available finds that GB subsidies reduce cost of production by 16 per cent while general services and environment services reduce cost of production by 11 per cent and 16 per cent respectively. The effect of decoupled payments is to reduce cost of production by 4.6 per cent. Crop wise analysis depicts that expenditure on GB subsidies and its components reduces the cost of production, though the magnitude differs across crops .

The results of these empirical analysis have important bearing on the on-going Agriculture negotiations at the WTO. The 2004 July framework provided a mandate for review and clarification of the Green Box criteria. Tightening the eligibility criteria for developed countries should ensure that only small farmers are eligible for GB subsidies and tightening of disciplines should also apply to different components of GB. Further the G20 proposal of fixed and unchanging base year would ensure that the trade and production distorting effects of GB are minimised.

APPENDIX-1

Data Envelopment Analysis (DEA)

DEA is used to evaluate the efficiency of a number of producers or DMU's (Decision Making Units). A typical statistical approach is characterized as a central tendency approach and it evaluates producers relative to an average producer. In contrast, DEA is an extreme point method and compares each producer with only the 'best' producers. A fundamental assumption behind an extreme point method is that if a given producer, A, is capable of producing Y(A) units of output with X(A) inputs, then other producers should also be able to do the same if they were to operate efficiently. Similarly, if producer B is capable of producing Y(B) units of output with X(B) inputs, then other producers should also be capable of the same production schedule. Producers A, B and others can then be combined to form a composite producer with composite inputs and composite outputs. Since this composite producer does not necessarily exist, it is sometimes called a virtual producer. The heart of the analysis lies in finding the 'best' virtual producer for each real producer. If the virtual producer is better than the original producer by either making more output with the same input or making the same output with less input then the original producer is *inefficient*. The 'best' virtual producer is calculated by linear programming.

Though the practice of extracting information from extreme observations to form the best practice production frontier makes the DEA sensitive to errors in data, the main advantage of this analysis is that it does not require the assumption of a functional form for the specification of the input–output relation.

In this paper total factor productivity (TFP) is measured using the Malmquist index methods described in Fare et al (1994) and Coelli, Rao and Battese (1998, Ch. 10,). This approach uses data envelopment analysis (DEA) methods to construct a piece-wise linear production frontier for each year in the sample. Initially a brief description of DEA methods is provided before going on to describe the Malmquist TFP calculations. Cost efficiency is calculated using an input oriented measure. This has also been described below.

DEA is a linear-programming methodology, which uses data on the input and output quantities of a group of countries to construct a piece-wise linear surface over the data points. This frontier surface is constructed by the solution of a sequence of linear programming problems – one for each country in the sample. The degree of technical inefficiency of each country (the distance between the observed data point and the frontier) is produced as a byproduct of the frontier construction method. DEA can be either input-orientated or output-orientated. In the input-orientated case, the DEA method defines the frontier by seeking the maximum possible proportional reduction in input usage, with output levels held constant, for each country. While, in the output orientated case, the DEA method seeks the maximum proportional increase in output production, with input levels held fixed. The two measures provide the same technical efficiency scores when a constant returns to scale (CRS) technology applies, but are unequal when variable returns to scale (VRS) is assumed. This paper assumes a VRS technology (the reasons for this are outlined in the Malmquist discussion below). Hence the choice of orientation is not a big issue in our case. However, an output orientation is selected because it would be fair to assume that, in agriculture, one usually attempts to maximise output from a given set of inputs, rather than the converse.

1. Output Oriented DEA

If one has data for N countries in a particular time period, the linear programming (LP) problem that is solved for the i^{th} country in an output-orientated DEA model is as follows:

$\max_{\varphi,\lambda} \varphi,$

$st\ -\varphi y_i + Y\lambda \geq 0,$

$x_i - X\lambda \geq 0,$

$\lambda \geq 0, \quad (1)$

where

y_i is a M×1 vector of output quantities for the i^{th} country;

x_i is a K×1 vector of input quantities for the i^{th} country;

Y is a N×M matrix of output quantities for all N countries;

X is a N×K matrix of input quantities for all N countries;

λ is a N×1 vector of weights; and

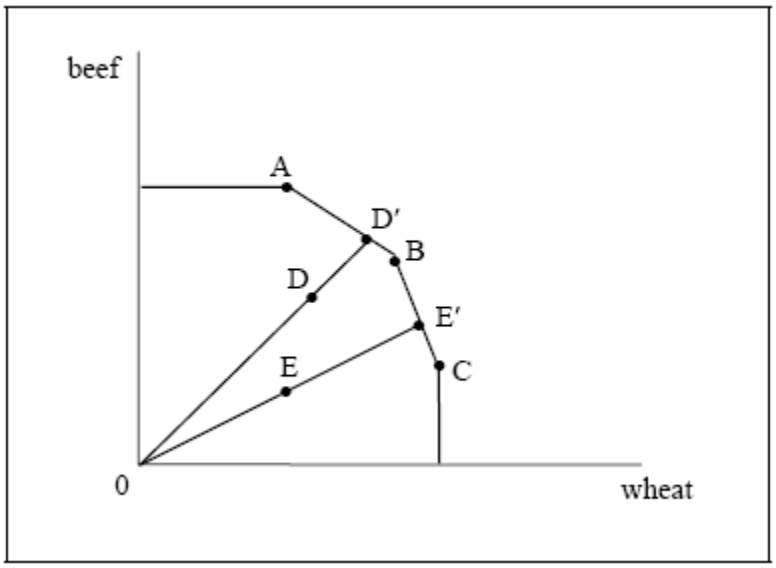
φ is a scalar.

Observe that φ will take a value greater than or equal to one, and that φ-1 is the proportional increase in outputs that could be achieved by the i^{th} country, with input quantities held constant. Note also that $1/\varphi$ defines a technical efficiency (TE) score which varies between zero and one (and that this is the output-orientated TE score reported in our results).

The above LP is solved N times, once for each country in the sample. Each LP produces a φ and a λ vector. The φ-parameter provides information on the technical efficiency score for the i^{th} country and the λ-vector provides information on the *peers* of the (inefficient) i^{th} country. The peers of the i^{th} country are those efficient countries that define the facet of the frontier against which the (inefficient) i^{th} country is measured. The DEA problem can be illustrated using a simple example. Consider the case where there is a group of five countries producing two outputs (say, wheat and beef). Assume for simplicity that each country has identical input vectors. These five countries are depicted in Figure A1.1. Countries A, B and C are efficient countries because they define the frontier.

Countries D and E are inefficient countries. For country D the technical efficiency score is equal to $TE_D = 0D/0D'$, and its peers are countries A and B. In the DEA output listing this country would have a technical efficiency score of approximately 70 per cent and would have non-zero λ-weights associated with countries A and B. For country E the technical efficiency score is equal to $TE_E = 0E/0E'$, (3) and its peers are countries B and C. In the DEA output listing this country would have a technical efficiency score of approximately 50 per cent and would have non-zero λ-weights associated with countries B and C. Note that the DEA output listing for countries A, B and C would provide technical efficiency scores equal to one and each country would be its own peer. For further discussion of DEA methods see Coelli, Rao and Battese (1998, Ch. 6).

Figure A1.1 Output-Orientated DEA.



2. Malmquist DEA analysis

The Malmquist DEA analysis is used when there is availability of panel data. Using the panel data an input–output based Malmquist TFP index is arrived at to measure productivity change, and to decompose this productivity change into technical change and technical efficiency change.

Fare et al (1994) specifies an output based Malmquist productivity change index as-

$$m_o\,(y_{t+1},\, x_{t+1},\, y_t, x_t) = \left[\frac{d^t_0\,(x_{t+1},\, y_{t+1})}{d^t_0(x_t, y_t)} \quad x \quad \frac{d^{t+1}_o(\, x_{t+1}, y_{t+1}\,)}{d^t_0(x_t, y_t)} \right]^{1/2}$$

This represents the productivity of the production point (x_{t+1}, y_{t+1}) relative to the production point (x_t, y_t). A value greater than one will indicate positive TFP growth from period t to period t+1. This index is, in fact the geometric mean of two output based Malmquist TFP indices. One uses period t technology and the other t+1 technology.

3. Cost Efficiency Analysis Using Input Oriented Method

Farrell[43](1957) illustrated his ideas using a simple example involving firms which use two inputs (x_1 and x_2) to produce a single output (y), under the assumption of constant returns to scale. Knowledge of the unit isoquant of the *fully efficient firm*, represented by SS′ in Figure A1.2, permits the measurement of technical efficiency. If a given firm uses quantities of inputs, defined by the point P, to produce a unit of output, the technical inefficiency of that firm could be represented by the distance QP, which is the amount by which all inputs could be

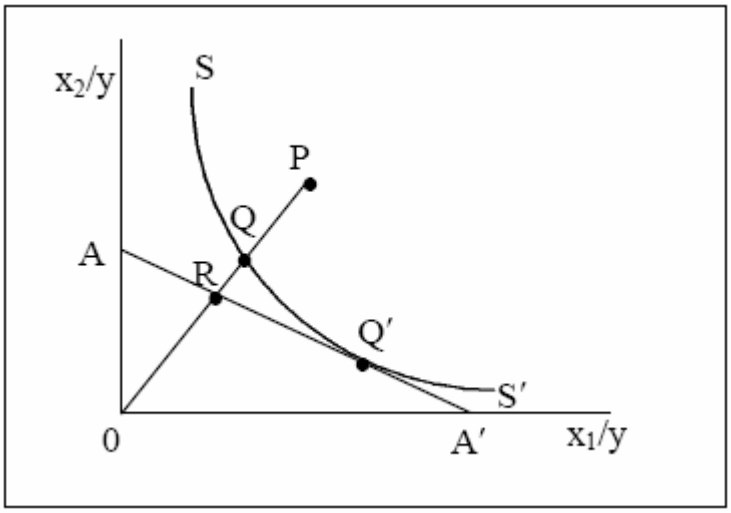
[43] Farrell, M. J. (1957), "TheMeasurement of Productive Efficiency," Journal of Royal Statistical, Society, Series A, General, 120:3.

proportionally reduced without a reduction in output. This is usually expressed in percentage terms by the ratio QP/0P, which represents the percentage by which all inputs could be reduced. The technical efficiency (TE) of a firm is most commonly measured by the ratio

$$TE_I = 0Q/0P, \quad (4)$$

which is equal to one minus QP/0P. It will take a value between zero and one, and hence provides an indicator of the degree of technical inefficiency of the firm. A value of one indicates the firm is fully technically efficient. For example, the point Q is technically efficient because it lies on the efficient isoquant.

Figure A1.2 Technical and Allocative Efficiency.



If the input price ratio, represented by the line AA′ in Figure A1.2, is also known, allocative efficiency may also be calculated. The *allocative efficiency (AE)* of the firm operating at P is defined to be the ratio

$$AE_I = 0R/0Q, \quad (5)$$

since the distance RQ represents the reduction in production costs that would occur if production were to occur at the allocatively (and technically) efficient point Q′, instead of at the technically efficient, but allocatively inefficient, point Q. The total *economic efficiency (EE)* is defined to be the ratio

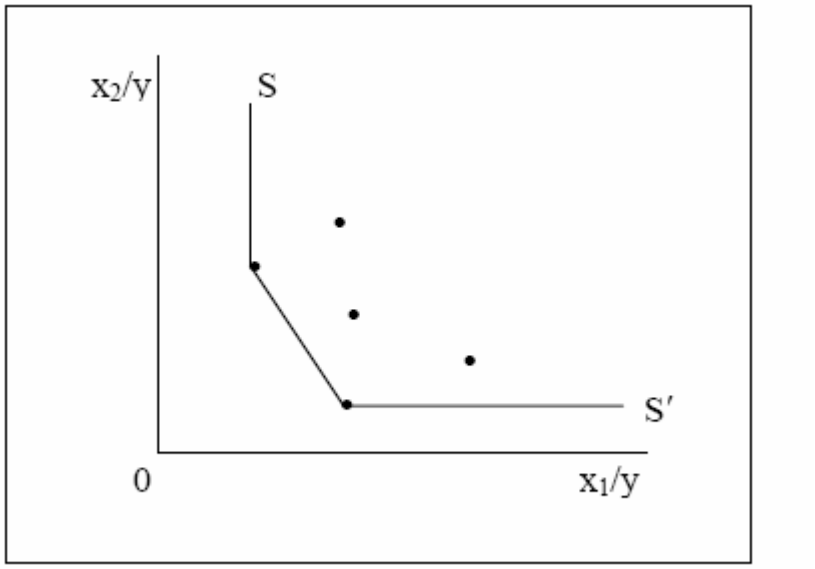
$$EE_I = 0R/0P, \quad (6)$$

where the distance RP can also be interpreted in terms of a cost reduction. Note that the product of technical and allocative efficiency provides the overall economic efficiency

$$TE_I \bullet AE_I = (0Q/0P)\bullet(0R/0Q) = (0R/0P) = EE_I. \quad (7)$$

Note that all three measures are bounded by zero and one.

Figure A1.3 Piecewise Linear Convex Isoquant



These efficiency measures assume that the production function of the fully efficient firm is known. In practice this is not the case, and the efficient isoquant must be estimated from the sample data. Farrell suggested the use of either (a) a non-parametric piecewise-linear convex isoquant constructed such that no observed point should lie to the left or below it (refer to Figure A1.3), or (b) a parametric function, such as the Cobb–Douglas form, fitted to the data, again such that no observed point should lie to the left or below it. Farrell provided an illustration of his methods using agricultural data for the 48 continental states of the US.

APPENDIX-2

CGE-GTAP Methodology and Aggregations

Computable general equilibrium analysis

As the global economy becomes increasingly integrated, there is growing demand for quantitative analyses of policy issues on a global basis, which is why computable general equilibrium (CGE) analysis has become a preferred tool. The multi-sector analyses carried out with the help of this tool are wide-ranging: from single-country to multi-country, incorporating all the features of factors and product markets.

CGE analysis is also useful for enabling assessments of the impact of domestic distortion on an individual sector/economy and its implications for the rest of the world. It thus helps address issues relating to trade liberalization undertaken both unilaterally and bilaterally.

Salient features of the CGE model

For this study, the Global Trade Analysis Project (GTAP) model prepared by the Centre for Global Trade Analysis was adapted from Hertel (1997). The model is capable of an economy-wide analysis of international economic issues, relating mainly to tariff protection/ taxation/subsidy. It is in the public domain and an overview of the model is available at: http://www.gtap.agecon.purdue.edu/. Simulations were performed using GTAP Version R6.0_final_release_22Dec04 for 2001 Base Year

A graphical overview of the model is provided in Brockmeier (1996) and Hertel (1997). The model assumes perfect competition and constant returns to scale technology. All the major economic agents are represented, such as consumer preference, firms' behaviour, factor markets, exports, imports and capital formation. Resources are assumed to be fully employed. The model is based on the Armington assumption (Armington, 1969) for modelling the import demand, which differentiates between domestic and imported goods and combines them with the constant elasticity substitution (CES) approach. Under the Armington assumption, it is assumed that internationally traded products are differentiated by country of origin. This is now a standard assumption of international CGE models used to generate smaller and more realistic responses of trade to price changes than implied by homogeneous products.

Armington assumed that in any one country, each industry produces only one product and that this product is distinct from the product of the same industry in any other country. For simplicity, he assumed there is only one consumer in each country. In the eyes of this consumer, the products of one industry which originate from different countries are a group of close substitutes. This set of assumptions is called the Armington assumption. It relates to the demand side of the model.

On the supply side, GTAP model typically incorporated the standard neoclassical assumptions of constant returns to scale and perfect competition in all industries. Multi-country computable general equilibrium (CGE) models used to analyse tariff and trade policy changes typically

incorporate the Armington structure which differentiates commodities by their country of origin (national product differentiation), and assumes them to be imperfect substitutes for each other.
Implications of Armington assumptions

1. Trade need not equalize prices of same 'good' from different countries
2. Trade now depends on preference parameters as well as on factor endowments
3. Preferences give every country market power in trade
4. There is no comparative advantage and hence no gains from trade due to product specialization;
5. The number of products is fixed and hence there are no gains from trade due to increased product variety; and
6. Large terms of trade effects tend to offset other gains from trade.

There are three causes of trade in an Armington model — differences in endowments, technology and national products differentiation.

Closure Adopted

It would be useful to elaborate the closure rule as applied to the current modelling analysis. We followed a standard book closure as given below:

"exogenous
pop
psaveslack pfactwld
profitslack incomeslack endwslack
cgdslack tradslack
ams atm atf ats atd
aosec aoreg avasec avareg
afcom afsec afreg afecom afesec afereg
aoall afall afeall
au dppriv dpgov dpsave
to tp tm tms tx txs
qo(ENDW_COMM,REG) ;
Rest Endogenous ;"

Database

As with the CGE model used for the present study, the database used is also taken from the GTAP as compiled by the Center for Global Analysis, Purdue University (United States). This database (GTAP Version R6.0_final_release_22Dec04) is compiled for bilateral exports, imports and tariffs of 87 major countries/regions for 57 tradable commodities (Dimaranan and McDougall, 2004 not listed in the references). All the trade flows for the 57 commodity categories are distinguished by their countries/regions of origin and destination, and on the basis of agents such as intermediate demand, final demand by private households, government and investment. It provides a method for allowing for varying import intensities by different economic agents within a country/region. The reference year for this database is 2001. The tariff data is mainly in the form of applied ad valorem rates.

For the present analysis, this paper aggregates the 57 GTAP commodity categories into 3 categories. Similarly, the 87 countries/regions are aggregated into 28 countries/regions for our model**.** See Tables A2.1 and A2.2 below:

The aggregations that are used to derive the modelling results are as follows:

Table A2.1 Regional Aggregation

	New	**Region**	**Comprising**
No.	Code	Description	old regions
1.	Devd	Other Developed Countries	New Zealand; Malta.
2.	EU	EU countries	Austria; Belgium; Denmark; Finland; France; Germany; United Kingdom; Greece; Ireland; Italy; Luxembourg; Netherlands; Portugal; Spain; Sweden.
3.	USA		United States.
4.	CAN		Canada.
5.	ARG		Argentina.
6.	AUS		Australia.
7.	NOR		Rest of EFTA.
8.	BRA		Brazil.
9.	CHL		Chile.
10.	IND		India.
11.	VEN		Venezuela.
12.	INDO		Indonesia.
13.	THAILAND		Thailand.
14.	MOR		Morocco.
15.	POLAND		Poland.
16.	SOUTHAFR		South Africa.
17.	SWITZERLAND		Switzerland.
18.	ROM		Romania.
19.	SLOVAN		Slovenia.
20.	PERU		Peru.
21.	JAPAN		Japan.
22.	KOREA		Korea.
23.	PHL		Philippines.
24.	MEX		Mexico.
25.	CZECH		Czech Republic.
26.	MAL		Malaysia.

27.	DCs	Developing Countries	Rest of Oceania; China; Hong Kong; Taiwan; Rest of East Asia; Singapore; Vietnam; Sri Lanka; Rest of North America; Colombia; Rest of Andean Pact; Uruguay; Rest of South America; Central America; Rest of FTAA; Rest of the Caribbean; Rest of Europe; Albania; Bulgaria; Croatia; Cyprus; Hungary; Slovakia; Estonia; Latvia; Lithuania; Russian Federation; Rest of Former Soviet Union; Turkey; Rest of Middle East; Tunisia; Rest of North Africa; Zimbabwe; Rest of SADC.
28.	LDCs	Least Developed Countries	Rest of Southeast Asia; Bangladesh; Rest of South Asia; Botswana; Rest of South African CU; Malawi; Mozambique; Tanzania; Zambia; Madagascar; Uganda; Rest of Sub-Saharan Africa.

Table A2.2 Sectoral Aggregation

	Old	sector		New	sectors
No.	Code	Description	No.	Code	Description
1	agriculture	agri prosducts	1	pdr	Paddy rice
			2	wht	Wheat
			3	gro	Cereal grains nec
			4	v_f	Vegetables, fruit, nuts
			5	osd	Oil seeds
			6	c_b	Sugar cane, sugar beet
			7	pfb	Plant-based fibers
			8	ocr	Crops nec
			9	ctl	Cattle, sheep, goats, horses
			10	oap	Animal products nec
			12	wol	Wool, silk-worm cocoons
			13	frs	Forestry
			19	cmt	Meat: cattle, sheep, goats, horse
			20	omt	Meat products nec
			21	vol	Vegetable oils and fats
			22	mil	Dairy products
			23	pcr	Processed rice
			24	sgr	Sugar
			25	ofd	Food products nec
			26	b_t	Beverages and tobacco products
2	Mnfcs	Manufacturing products	11	rmk	Raw milk
			14	fsh	Fishing
			15	coa	Coal
			16	oil	Oil
			17	gas	Gas
			18	omn	Minerals nec
			27	tex	Textiles
			28	wap	Wearing apparel
			29	lea	Leather products
			30	lum	Wood products
			31	ppp	Paper products, publishing
			32	p_c	Petroleum, coal products
			33	crp	Chemical, rubber, plastic prods
			34	nmm	Mineral products nec
			35	i_s	Ferrous metals
			36	nfm	Metals nec
			37	fmp	Metal products
			38	mvh	Motor vehicles and parts
			39	otn	Transport equipment nec
			40	ele	Electronic equipment
			41	ome	Machinery and equipment nec
			42	omf	Manufactures nec
3	Svces	Services	43	ely	Electricity
			44	gdt	Gas manufacture, distribution

			45	wtr	Water
			46	cns	Construction
			47	trd	Trade
			48	otp	Transport nec
			49	wtp	Sea transport
			50	atp	Air transport
			51	cmn	Communication
			52	ofi	Financial services nec
			53	isr	Insurance
			54	obs	Business services nec
			55	ros	Recreation and other services
			56	osg	Pub Admin/ Defence/ Health/ Educat
			57	dwe	Dwellings

APPENDIX-3

State of Play of WTO Negotiations on GB

(i) General Services

With respect to general services in paragraph 2 of Annex 2, suggestions have been made that an additional sub-paragraph (h) be added with a view to cover settlement, land reform and any programme related to food and livelihood security and rural development in developing country Members. Specifically the following support measures are being discussed for inclusion in the GB: agrarian, land and institutional reform, including related services such as settlement programmes, issuance of property titles, employment assurance, nutritional security, poverty alleviation, soil conservation and resource management, and drought management and flood control. In addition, services related to developing country programmes on food and livelihood security and rural development and infrastructure provision are also sought to be covered in the GB.

(ii) Public stockholding for food security purposes

Expenditure in relation to the **accumulation** and **holding** of stocks of products as a part of food security programme are covered in the GB. Under footnote 5 of the Agreement on Agriculture, government programmes in developing countries under which stocks of foodstuffs for food security purposes are **acquired** and **released** at administered prices are included in the GB, provided that the difference between the acquisition price and the external reference price is accounted for in the AMS. There have been suggestions to amend footnote 5 to exclude from the AMS, the acquisition costs of stocks of foodstuffs by developing countries or at least as regards supporting low-income or resource-poor producers. Put in another way, some of the developing countries are seeking an unambiguous clarification that the acquisition costs of stocks of foodstuffs would be accommodated within the 10 per cent *de minimis* allowance.

(iii) Domestic food aid

Under paragraph 4 of Annex 2, expenditures in relation to the **provision** of domestic food aid have been included in the GB. However, it has been stipulated that food **purchases** by the government shall be made at **current market prices**. It might be argued that this stipulation rules out the possibility of inclusion of those measures in the GB that require food purchases by the government at subsidized prices. The stipulation renders the provision almost ineffective, at least for developing countries, as far as procurement from poor farmers with a view to addressing rural poverty is concerned.

Suggestions have been made to amend footnotes 5 and 6 (related to paragraphs on stockholding for food security purposes and domestic food aid) to cover the acquisition of foodstuffs at subsidized prices when generally procured from low-income or resource-poor producers in developing countries with the objective of fighting hunger and rural poverty. Some WTO Members have raised concern that this would amount to an effective departure from the present provision that 'food aid purchases by the government shall be made *at current market prices*'[44].

[44] Chairs Reference Paper, Committee on Agriculture, Special Session Domestic Support,12/04/2006

(iv) Direct payments to producers

Paragraphs 5–13 of Annex 2 of the Agreement on Agriculture contain the eligibility criteria and the stipulations on the amount of direct support which can be covered under the GB. Different categories of direct payment specified in paragraphs 6–13 of Annex 2 are: decoupled income support measures; income insurance and safety-net programmes; natural disaster relief; a range of structural adjustment assistance programmes; and certain payments under environmental programmes and under regional assistance programmes. In order that a support provided through direct payment to producers qualifies for inclusion in the GB, it must satisfy the basic criteria (support being provided through public funds and the support not providing price support to producers) as well as policy-specific criteria set out in paragraphs 6 to 13 of Annex 2. In addition, any other type of direct payment not specified in paragraphs 6–13 of Annex 2 can be covered in the Green provided it satisfies the basic criteria and **some, but not all,** of the policy-specific criteria for decoupled income support in paragraph 6 (b) – (e).

Broadly, there are **five** negotiating suggestions regarding the overarching provision on direct payments. First, it has been proposed that paragraph 5 should explicitly state that direct payments should not be linked to production levels, including input levels therein. Second, it has been proposed that on-going payments be based on activities in a fixed and unchanging historical base period. Third, a suggestion has been made to amend the last sentence of paragraph 5 thereby requiring that direct payments exempt from reduction commitments conform to (a revised) criterion 6(a) in addition to criteria 6(b) through (e) of paragraph 6. Related to this is the fourth suggestion, which seeks to delete the last sentence of paragraph 5, thereby, making paragraphs 6 to 13 as the exhaustive list for possible direct payment support. The result of this proposal would be that if a direct payment support measure does not meet the criteria specified in paragraphs 6 to 13, it cannot be included in the GB. This suggestion has met with considerable resistance from some of the developed countries. Fifth, details of notification requirements concerning direct payments have been elaborated.

(v) Decoupled income support

Paragraph 6 of Annex 2 addresses two issues—**eligibility criteria** for decoupled support and requirements relating to the **amount** of decoupled support. Eligibility for such payments is required to be determined by clearly-defined criteria such as income, status as a producer or landowner, factor use or production level in a defined and fixed base period. The basis for the amount of decoupled support has been specified in negative terms namely, the basis on which the amount for decoupled support should not be determined. It has been specified that the amount of decoupled support shall not be based on the following:

(a) the type or volume of production (including livestock units) undertaken by the producer in any year **after** the base period;

(b) the prices, domestic or international, applying to any production undertaken in any year after the base period; and

(c) factors of production employed in any year after the base period.

It needs to be highlighted that the criteria for decoupled income support focus on the distinction between the base period and the time after the base period. **The existing provisions permit**

decoupled income support to be coupled to factors that occurred during the base period, but not after it.

Changes have been suggested to constrain some of the eligibility criteria for decoupled income support. It has been suggested that eligibility for such support shall be determined by criteria of **low** level of income, landholding and production in a notified and unchanging base period. However, what could constitute low level of income, landholding and production has not been specified.

At the same time it has been proposed that developing country Members not previously users of the GB should not be precluded from establishing an appropriate base period for providing decoupled income support. This would permit new users to give GB decoupled income support.

Some countries have suggested adding the criteria that land, labour or any other factor of production should not be required to be in 'agricultural use' in order to receive payments.

It has also been proposed that an additional sub-paragraph (f) be added to paragraph 6 to reflect that direct payments under paragraph 6 should not be made along with Amber Box or Blue Box support if the total value of support exceeds a certain percentage of the annual value of production of a given product.

There has been firm resistance from certain developed countries to altering the criteria in those ways that might be described as 'constraining' in nature, particularly as regards the proposal on sub-paragraph (f).

(vi) Income insurance and income safety- net programmes

Paragraph 7 of Annex 2 provides the eligibility criteria, and the ceiling amount of payment, for income insurance and income safety-net programmes. An income loss exceeding 30 per cent of the average income derived from agriculture would be eligible for this support The average income can be derived on two bases. First, it can be based on the average income in the preceding three-year period. Second, it can be based on a three-year average for the preceding five-year period, after excluding highest and the lowest incomes. The amount of payment shall be less than 70 per cent of the producers' income loss in the year that the producer becomes eligible for assistance.

At a broad level, negotiating proposals have been made on eligibility criteria and the amount of assistance under income insurance and income safety-net. First, in respect of the eligibility criteria, the average income for the preceding three year period is sought to be replaced by average income for at least the preceding five year period. This would make the data on income more representative and smoothen short-term and temporary fluctuations that might otherwise arise. Second, it has been proposed that different eligibility criteria be applied for a developing country. While the different eligibility criteria have not been specified in the negotiating proposals, it has been stated that the specific criteria shall be defined in the concerned Member's national legislation. Third, the proposals seek to specify that the amount of assistance shall be only up to 70 per cent of the producer's reference income (and not of the income loss). Fourth, it has been proposed that for developing countries the 70 per cent ceiling may not apply. Instead, the ceiling could be specified in the national legislation of the concerned developing country.

(vii) Payments for relief from natural disaster

Paragraph 8 provides for payment for relief from natural disasters by way of either direct payments or through government financial participation in crop insurance schemes. **Eligibility for both types of assistance is the same and requires formal recognition that a natural disaster has occurred, or is occurring.** Further, production loss should exceed 30 per cent of the average of production during the reference period. Losses of income, livestock, land or other factors of production are eligible for payments. The amount of payment shall compensate only for the cost of replacing the losses.

Negotiating proposals have been made on the eligibility criteria and the payments. Some of the proposals seek to make a distinction between eligibility criteria for the two types of assistance under this paragraph. In respect of government financial participation in crop insurance, the requirement for a formal recognition that a natural disaster has occurred, or is occurring, is sought to be deleted. Another proposal states that in respect of developing countries, the eligibility criteria should be specified in the national legislation. It has also been proposed that loss of crop should be eligible for payment.

The proposal to delete the requirement of formal notification of disaster effectively creates an additional avenue for providing GB assistance, that is, for crop insurance schemes not linked with natural disasters. Under this additional avenue, production loss which occurs on account of factors other than natural disasters, would also become eligible for assistance.

(viii) Structural adjustment assistance through producer/ resource retirement programmes

No negotiating proposals have so far been made in respect of the provisions relating to structural assistance through resource / producer retirement programmes.

(ix) Structural adjustment assistance through investment aids

Paragraph 11 of Annex 2 provides the eligibility criteria and conditions attached to the amount of support for structural adjustment assistance. Eligibility criteria for support under structural assistance programmes have not been clearly spelt out in this paragraph of Agreement on Agriculture. However, eligibility criteria are required to be specified in the government's programmes for structural assistance. It has been specified that amount of payments under structural assistance programmes shall not be related to or based on the type or volume of production in any year after base period.

It has been proposed that structural disadvantages must be clearly defined in the context of government programmes for reprivatization of agricultural land. As far as the amount of support under structural adjustment assistance is concerned, it has been suggested that the base year should be fixed as an unchanging historical period. Developing countries which have so far not made use of this type of payment shall not be precluded from establishing appropriate base period.

(x) Payments under regional assistance programmes

Provisions in paragraph 13 provide the eligibility criteria and the negative basis for payments under regional assistance programmes. Eligibility for such payments is mandated to be limited to producers in disadvantaged regions, each such region being a clearly designated contiguous geographical area with a definable economic and administrative identity. The region is required to be considered as disadvantaged on the basis of neutral and objective criteria. The amount of payment under regional assistance programmes are required to be delinked from prices and production in any year after the base period.

The negotiating proposals seek to exempt developing countries from the requirement that a disadvantaged region constitute a clearly designated contiguous geographical area with a definable economic and administrative identity. In order to prevent updating of base periods, it has also been proposed that the base period be fixed, historical and unchanging.

APPENDIX-4

Translog Equation and its Partial Derivatives

$$LnC = \propto + \beta_1 LnY + 1/2\beta_2 (LnY)^2 + C_1 LnG + 1/2C_2 (LnG)^2 + \lambda_{1i} LnGLnP_i + \lambda_{2i} LnYLnP_i + \lambda_{3i} LnYLnG + \gamma_i LnP_i LnP_j \quad (1)$$

Where C = Total Cost, Y= Total Production, G = Adjusted GB Subsidy, Pi = Input Prices

$$E = \frac{\partial LnC}{\partial LnG} = C_1 + C_2 LnG + \lambda_{1i} LnP_i + \lambda_{3i} LnY \quad (2)$$

E is the elasticity of cost w.r.t. GB subsidies

$$\frac{\partial E}{\partial LnG} = C_2 \quad (3)$$

Equation 3 implies absolute change in elasticity due to 1 percent change in G

$$\frac{\partial LnC}{\partial LnP_1} = \frac{dC}{dP_1}\frac{P_1}{C} = \frac{Q_1 P_1}{C} = S_1 = \lambda_{11} LnG + \lambda_{21} LnY_i + \gamma_2 LnP_2 + +\gamma_2 LnP_2 + \gamma_3 LnP_3 + \gamma_4 LnP \quad (4)$$

S_1 is the share of input 1 in total cost using Shepherd's lemma

$$\frac{\partial S_1}{\partial \ln G_1} = \lambda_{11} \quad (5)$$

Equation 5 implies absolute change input share due to 1 percent change in G

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