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Impact of Green Box Subsidies on Agricultural Productivity, Production and International Trade



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Abstract: *The paper provides empirical evidence on production and trade distorting effects of Green Box subsidies of the developed countries. It reviews the theoretical and empirical literature which argues that the impacts of Green Box subsidies on production and trade operate via increases in risk taking capacities, land prices, availability of credits, labour participation, and expectations. It traces the "box-shifting" of subsidies by developed countries since 1995 under the reforms of Farm Bills of USA and Common Agriculture Policies (CAP) of EU. The paper estimates the impact of Green Box subsidies on agriculture productivity and technical efficiency in 26 countries for the period 1995-2007, using Data Envelopment Analysis (DEA). The results show that GB subsidies increased agricultural productivity by around 60% in EU and 51% in USA in this period. Further, the paper uses Agriculture Trade Policy Simulation Model (ATPSM) to estimate the impact of cuts in GB subsidies of 40% in USA (excluding food stamps) and 50% in EU (de-coupled payments) in 2007; and secondly, to estimate the impact of capping of GB subsidies at 2001 level. The impact is estimated on agriculture production, export and import volumes, export revenue and import costs in both developing and developed regions, including LDCs and Net Food Importing Countries (NFIC). Results show that a cut of 40% and 50% in GB subsidies of USA and EU can lead to a major restructuring of agricultural production and international trade. Import volumes of agricultural products rise substantially in EU (35%) and USA (67%) with an increase of 17% in export revenue of developing countries. LDCs gain in terms of rise in export volume and revenues and a fall in their import costs. NFIC also gain in terms of exports with no rise in their import costs. A capping of GB subsidies at 2001 level can lead to substantial gains to developing countries as their export revenues increase by 55%. LDCs and NFIC increase their production of agricultural products (not necessary food) while their import costs decline. Given the substantial and incessant rise in Green Box subsidies since 2000, the paper further provides broad principles on disciplining Green Box subsidies and suggests prioritising this in the post Bali work program.*

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Impact of Green Box Subsidies on Agricultural Productivity, Production and International Trade

1. Introduction

The multilateral trading rules were envisaged to enhance the development impacts of international trade on global economy and discourage trade-distorting domestic policies which affect competitiveness. These disciplines became particularly important for agriculture products as agriculture sector provides maximum employment to the world's poor and offers comparative advantage to many developing and least developed countries. The Agreement on Agriculture (AoA), which was negotiated in the 1986-94 Uruguay Round of multilateral trade negotiations, marked a significant step towards bringing trade-distorting domestic support or agricultural subsidies, particularly in the developed countries, into the ambit of international disciplines. Agricultural subsidies were grouped under three boxes- "Amber Box"- all domestic support measures which distort production and trade; "Blue Box"- any domestic support measure that would normally be in the amber box, is placed in the blue box if the support also requires farmers to limit production; and "Green Box"- domestic support measures which are not trade distorting, or at most cause minimal distortion. In Doha Development Round of multilateral trade negotiations, which began in 2002, considerable progress was made in these negotiations and in July 2004 an agreement was reached on a framework, while modalities remained in discussions. International disciplines on domestic support, as they stand in 2014, include reduction in all payments in amber box while those in green box are exempted from reduction commitment. Detailed rules on green box payments are set out in Annex 2 of AoA and are expected to cause minimal distortions in production and trade.

Following AoA, there have been significant reductions in domestic support measures under amber and blue box in developed countries. The total aggregate measure of support (AMS- which combines all supports for specified products and those that are not product-specific into a single figure) declined drastically for all developed countries in 2010 as compared to 1995. In US, total AMS declined from USD 6.2 billion in 1995 to USD 4.1 billion in 2010; while in EU this declined from € 50.1 billion to € 6.5 billion. Similar decline in total AMS was experienced by Japan (from yen 3,507 billion to yen 565 billion).

However, the decline in amber box and blue box subsidies have been more than compensated by substantial increases in Green Box (GB) subsidies in these countries. US increased its GB subsidies from USD 46 billion in 1995 to USD 120 billion in 2010; while EU's GB subsidies increased from € 9.2 billion to € 68 billion. However, Japan's GB subsidies have declined from yen 3,169 billion to yen 1,408 billion. Australia, New Zealand, Norway and Switzerland have also seen a rise in their GB subsidies. This "box-shifting" of subsidies from 'amber' to 'green' can be acceptable to WTO members, if these measures comply with the fundamental principle of being minimal production and trade distorting. However, if this is not so and the subsidies provided in 'green box' is found to be production or trade distorting, then there is a strong case for reopening the issue of domestic support provided under green box in the post Bali work program.

In this context, the paper empirically estimates the impact of GB subsidies provided by developed countries on productivity, production and international trade in agriculture. Section 2 of the paper illustrates trends in box-shifting in select developed countries; section 3 provides a brief review of existing theoretical and empirical literature on production and trade distorting effects of GB subsidies; section 4 presents results of data envelopment analyses (DEA) which estimates the impact of GB subsidies on agricultural productivity in 26 countries over the period 1995-2010; section 5 presents the results of the impact of reduction in GB subsidies on production, export volumes, import volumes, export revenues and imports costs using Agriculture Trade Policy Simulation Model (ATPSM). Results are presented at the regional level including for least developed countries (LDCs) and Net Food Importing Countries (NFIC); section 6 provides suggestions on disciplining green box subsidies and section 7 summarizes and concludes.

2. Trends in Domestic Support in Agriculture: The "Box Shifting"

2.1 *The Domestic Support Commitments*

The idea of exempting production and trade-neutral subsidies from WTO commitments was first proposed by US in 1987 and subsequently endorsed by EU². The rationale for supporting green box was to compensate farmers in the developed countries for any potential losses following agriculture reforms and allow the governments to deliver on public goods and fulfill their policy objectives without disrupting international trading pattern. The underlying reason was also to make progress in WTO negotiations in the face of stiff resistance from the farmers in the developed countries.

The AoA has very specific criteria on programs that can be classified under blue box and green box. The blue box policies are production-limiting and payments are based on fixed yield and acreage. These payments are required to be limited to 85 per cent of a base level of production. GB subsidies, on the other hand, are not to be linked to current production or prices. Annex 2 of AoA lists categorically the programs under green box with the general criteria that these programs must have no or at most minimal trade or production distorting effects. Green box applies to both developed as well as developing countries, although in case of developing countries special treatment is provided in terms of government stockholding programs for food security purposes and subsidized food prices for poor. These must be funded by the government and should not involve transfers from consumers or provide price support to producers.

The programs categorized under "Green Box" include:

- i. **General services** provided by governments like agricultural training services and extension and advisory services, inspection services, infrastructural services, marketing and promotional services, water supply facilities etc.

²Stancanelli, N. (2009), "The Historical Context of the Green Box", In Agricultural Subsidies in the WTO Green Box.

- ii. ***Decoupled income support*** or direct payments to producers delinked with their production decisions.
- iii. ***Public stockholding programs*** for food security purposes.
- iv. ***Domestic food aid***
- v. ***General research***, research related to particular products, pests and disease control, etc
- vi. ***Income insurance and income safety-net programs***
- vii. ***Payments for relief from natural disasters***
- viii. ***Structural adjustment assistance through producer retirement programs***
- ix. ***Structural adjustment assistance provided through resource retirement programs***
- x. ***Structural adjustment assistance through investment aids***
- xi. ***Environmental programs***
- xii. ***Regional assistance programs***

Each of the above programs has guidelines for defining their eligibility.

Correspondingly, the Aggregate Measure of Support (AMS) is the annual level of support- which is the sum of expenditures on non-exempted domestic support, aggregated across all commodities and policies. This includes both product-specific as well as non-product specific support and excludes GB subsidies. The AMS is determined by the member country's support provided in the base period, identified as 1986-88. The member countries agreed to limit their amber box domestic support to a level at or below the level of domestic support in their base period. The implementation of this commitment began in 1995 with developed countries given 6 years and developing countries 10 years to discipline the extent of their domestic support. It was agreed that developed countries would reduce their AMS by 20 per cent and developing countries by 13 per cent in the specified period.

In addition to this, the *de minimis* provisions of the Agreement states that there is no requirement to reduce trade-distorting domestic support in any year if the aggregate value of product-specific support does not exceed 5 per cent of the total value of production of the agricultural product and non-product specific support is less than 5 per cent of total agricultural production. This applies to developed countries while for developing countries the *de minimis* ceiling is 10 per cent. It is interesting to note that the Doha commitments on reducing domestic support has a harmonizing approach with maximum reductions undertaken by countries which provide largest support in the past. Accordingly, for US the overall trade distorting support (OTDS), which includes current total AMS, *de minimis* AMS support and blue box support, will decline from \$48.5 billion to \$ 14.5 billion and the existing Total AMS of \$19.1 billion will drop to Bound AMS of \$7.6 billion. While for EU, final Bound OTDS would be 23.8 billion euro and the Bound Total AMS would be reduced from 72.2 billion euro to 21.7 billion euro (Orden 2013).

2.2. The Changing Pattern of Domestic Support in Developed Countries

Following their WTO commitments on domestic support, developed countries, especially EU, USA and Japan have drastically reduced their amber box domestic support. This has been in line with the agriculture reforms undertaken in these countries. However, the domestic support in green box has increased substantially, in some cases more than the reductions in amber box subsidies.

2.2.1 'Box Shifting' by EU in CAP

EU has reformed its common agriculture policy (CAP) considerably in the last two decades. CAP was designed to influence agricultural prices, output and incomes of the farmers throughout EU and accounted for roughly 40% of total EU budgetary expenditures. CAP is based on two pillars, where pillar 1 support includes both direct payments to farmers (80% of total support) and market management measures; and pillar 2 support focuses on improving competitiveness of agriculture and forestry, improving the structural and environmental performance of agriculture and promoting local/rural development. While pillar 1 expenditures are fully funded by EU, pillar 2 expenditures are co-financed by Member States and the EU budget.

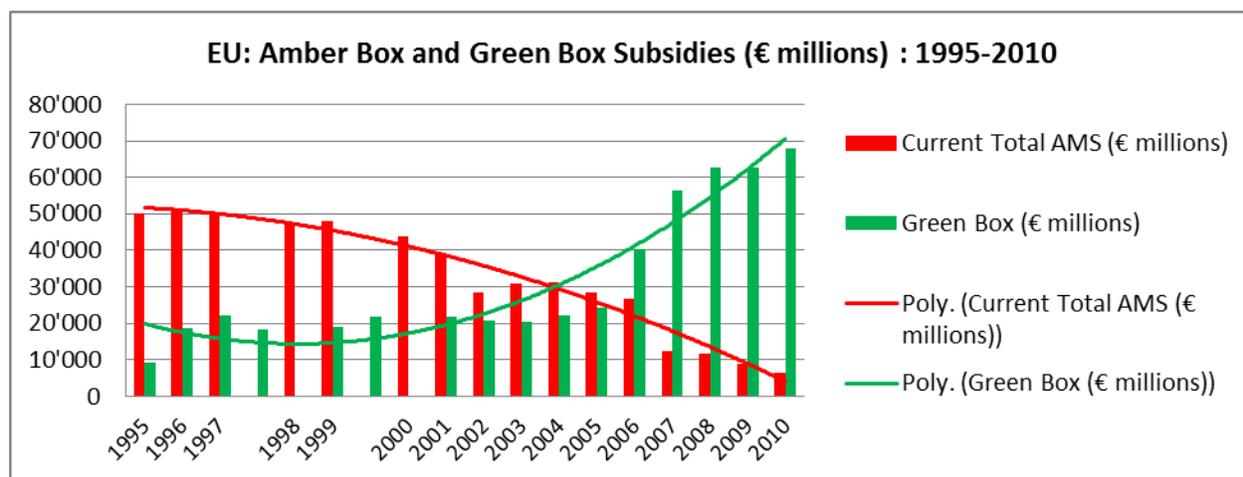
To make CAP expenditures more acceptable internationally, there have been considerable reforms, beginning with the MacSharry reforms of 1992 which reduced market price support and introduced direct support. The decoupling of direct payments from production (Single Farm Payment- SPF) was encouraged in 2003 reforms. However, it has been pointed out that the link with land input still remained as payments go to farmers who keep their land in 'good agricultural condition' which is to mean that it is ready to produce (EuroCare GmbH, 2010).

The new CAP (2014-2020), maintains the two pillars, although in real terms the amounts of domestic support declines by 1.8% for pillar 1 and 7.6% for pillar 2 (in 2011 prices). The total amount allocated is EUR 362.8 billion for the period 2014-2020, of which EUR 277.8 billion (76.5%) will be spent on direct payments and market related expenditures (pillar 1). To increase agricultural competitiveness, the new CAP reforms have removed all the existing restrictions on production volumes especially for sugar, dairy and the wine sector. It aims to facilitate producer cooperation which will reduce costs of farming, improve access to credit and help in adding value to primary sector. Support will be extended to set up producer groups and encourage product differentiation and promote on-farm processing and adding value.

Although the payments are decoupled from products, the payments under new CAP remain coupled with producers of agricultural products, providing them with new risk insurance schemes including insurance schemes for crops, animals and plants and responsive safety net measures. Start-up aid will be given to young farmers, expenditures on innovation and training is increased and new management toolkit is introduced which include mutual funds and income stabilization tool. 'Green direct payments' have been introduced, which account for 30% of the national direct payment envelope and special package of direct payments are offered to small farmers. Direct payments are no longer based on uneven historical references but are now based on converging per hectare payment at national or regional level.

The reforms in CAP in EU have over time reduced the domestic support in amber box but steadily increased the subsidies in green box. Figure 1 depicts the box shifting of EU. Domestic support in amber box declined from € 50 billion in 1995 to € 30.8 billion in 2003 and further reduced to €6.5 billion in 2010. However, domestic support in green box increased from € 9.2 billion in 1995 to € 20.4 billion in 2003 and reached € 68 billion in 2010. In 2010, the total domestic support provided under green box exceeded that provided under amber box in 1995. Most of the domestic support scheduled under the new CAP falls in the green box with amber box support being only around 8% of the total domestic support in the two boxes.

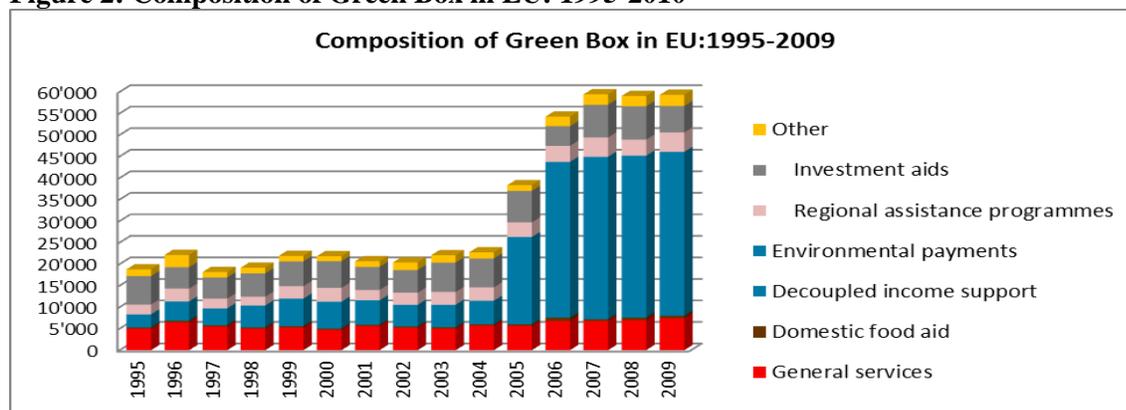
Figure 1: Current Total AMS and Green Box Subsidies in EU: 1995-2010



Source: based on WTO Notifications: 1995-2010

Figure 2 shows the change in composition of green box subsidies over time in EU. There has been drastic fall in share of general services provided under green box subsidies in EU. Its share fell from 27% in 1995 to 23% in 2003 and further to 12% in 2009-10. Share of decoupled payments has increased substantially from 1% in 1995 to 37% in 2005 and 49% in 2009-10. Shares of environmental payments, regional assistance programmes and investment aids have declined from 15%, 12% and 35% respectively in 1995 to 10%, 7% and 10% in 2009-10. Share of domestic food aid has remained around 1% -2% throughout the period.

Figure 2: Composition of Green Box in EU: 1995-2010



Source: based on WTO Notifications: 1995-2010

2.2.2 'Box Shifting' by USA

Similar to EU experience, the US Farm bills have also experienced drastic changes over the last two decades. One of the major changes came in 1996, when it was decided to eliminate farm subsidies over the next seven years and alternatively offer direct payments to farmers based on the size of their land. The US Farm Act of 2002 included income support to growers of selected commodities, including wheat, feed grains, cotton, rice, oilseed, sugar and dairy. The income support was given largely through direct payments, counter-cyclical payments and marketing loans. 27% of total actual spending of \$271 billion in 2002-07 was spent on commodity support while 67% was spent on food stamps. The 2008 Farm Act budgeted for \$288 billion in relief over five years, but in 2010 alone, around 80% of the total spending from the Farm Bill went towards domestic food assistance program and 10% to commodity programs.

The Farm Bill of 2014 eliminates direct and countercyclical payments to farmers and in turn offers expanded crop insurance programs for risk-management. These include new programs like- Price Loss Coverage and Agriculture Risk Coverage. The farmers can choose between the two programs. Price Loss Coverage pays out if crop prices fall too low, or if farm revenue falls below certain benchmarks. The reference price for assessing the fall has been raised in the new Farm Bill than the parameters in the 2008 farm bill. Agriculture Risk Coverage covers those losses which normally would not be covered by crop insurance. This is to maintain farm revenue and pays certain percentage of farm revenue if they fall below historic benchmarks, either for individual farm operations or for all the farms in a county. Payments are triggered when actual crop revenue drops below 86% of historical or "benchmark" revenue. But these farm programs are separate from a producer's decision to purchase crop insurance. However, farmers selecting the Price Loss Coverage (but not ARC) are also eligible to purchase an additional subsidized crop insurance policy to protect against "shallow losses."

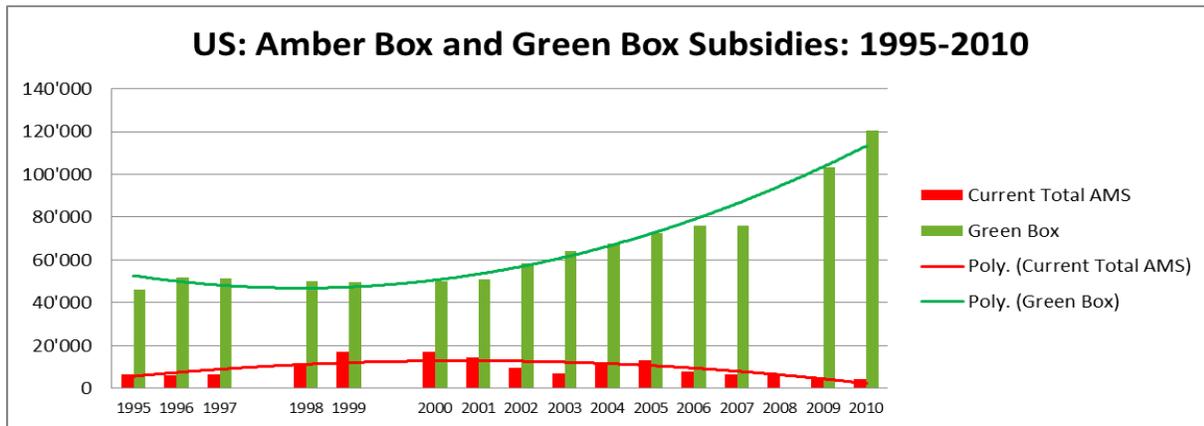
Interestingly, to compensate cotton producers, a new crop insurance policy for cotton producers is introduced called Stacked Income Protection Plan (STAX) which is similar to Area Revenue Protection. It covers revenue losses of not less than 10 per cent and not more than 30 per cent of expected county revenue. Producers receive a premium discount equal to 80 per cent of the STAX premium, and on behalf of the producers an administrative and operative expense of 12 per cent of premium is paid to the crop insurance companies. Further, Farm Bill 2014 reauthorizes many of the larger conservation programs and makes available subsidized crop insurance to producers, who purchase a policy to protect against losses in yield, crop revenue, or whole farm revenue.

The Bill envisages spending \$956 billion over next 10 years, of which \$756 billion is for nutrition assistance and \$200 billion is for the agriculture portion. Within the agriculture portion, \$90 billion is budgeted for crop insurance programs over the next 10 years, \$58 billion for conservation, and \$44 billion for farm commodity programs. The budget of the Farm Bill 2014 (\$478 for five years) is much higher than Farm Bill 2008 (\$288 billion), with budget for food stamps (SNAP- Supplemental Nutrition Assistance Program) doubling in every Farm Bill and growing from \$17 billion in 2000 to \$38 billion in 2008 and \$80 billion in 2014. According to SNAP, any household with one person (without disability or senior person) with maximum gross monthly income of \$1,245 per month (around \$40 per day) is eligible for food stamps. These can be used to buy fruits and vegetables and organic agricultural products. The growing demand is anticipated to lead to higher investments in local and regional food systems and organic

agriculture providing greater opportunities for small and mid-sized farmers, especially crop farmers, to diversify. The food stamps, which attract a dominant share in Farm Bill expenditures, therefore help in boosting demand for the agricultural products.

Figure 3 depicts the shifting of domestic support from amber box to green box in the period 1995-2010. The domestic support in amber box increased from \$6.2 billion in 1995 to \$9.6 billion in 2002 and declined to \$6.2 billion in 2008 and reached \$4.1 billion in 2010. While green box subsidies increased from \$46 billion in 1995 to \$ 58.3 billion in 2002 reaching \$120 billion in 2010.

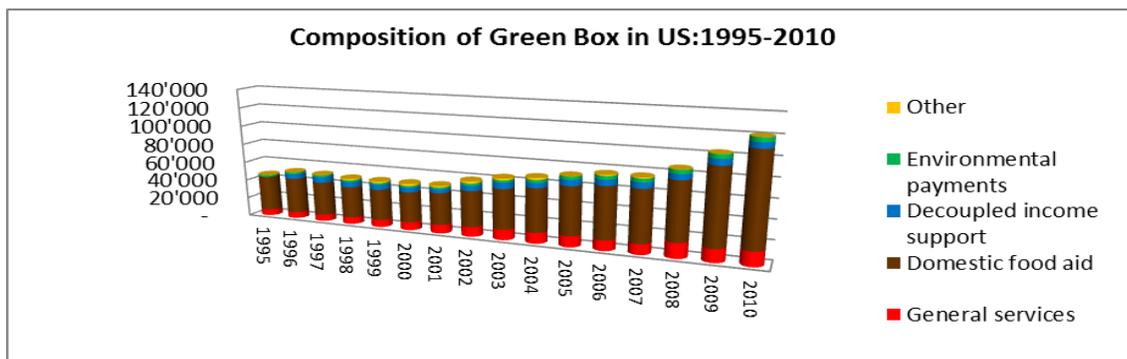
Figure 3: Current Total AMS and Green Box Subsidies in USA: 1995-2010



Source: based on WTO Notifications: 1995-2010

Along with box-shifting of domestic support the composition of green box subsidies have also changed over time in USA evolving from one farm bill to the other. While environment payments have remained between 3-4% of total green box domestic support from 1995-2010, food aid has increased from 65% in 2002 to around 79% of total green box subsidies in 2010. Expenditure on general services and decoupled payments has declined from 17% and 9% respectively of total GB subsidies in 2002 to 12% and 5% in 2010 (Figure 4).

Figure 4 Changing Composition of Green Box in US: 1995-2010



Source: based on WTO Notifications: 1995-2010

Although, it can be argued that food aid simply allows poor US citizens to feed themselves cheaply with food stamps, there are studies which argue this creates an artificial domestic demand leading to a rise in agricultural production. Berthelot (2005) points out that although the agreed shops selling this food also import, a large part of the food comes from agri-food surpluses collected by Commodity Credit Corporation and has therefore the effect of creating domestic demand and supporting the prices of the corresponding products, the food aid is here clearly coupled.

Further, Debar and Blogowski (1999)³ estimate for 1996 "the net equivalent aid to agricultural production" of the US domestic food aid, on the following bases: a) 88.4% of US consumers purchases of food were of an US origin in 1996; b) the share of those purchases at the retail prices going to farmers was 25%; c) every dollar granted in food stamps induces a net additional consumption of food between 20 to 45 cents. The results show that "the net equivalent aid to agricultural production" was \$2.6 billion in 1996 which was around 6.9% of the domestic food aid value, a percentage which can be extrapolated to the other years. In 2010, this equivalent aid to agricultural production was \$ 6.6 billion which is more than their amber box subsidies in 2010.

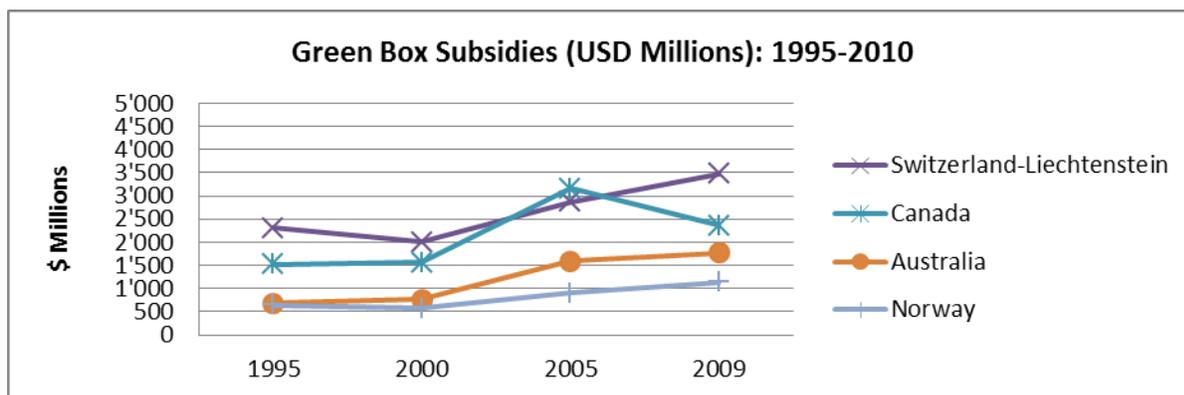
The rising trend in domestic support measures in green box is not just limited to US and EU. Other developed countries have also increased their green box subsidies. The domestic support under green box has increased more than 150% in Australia, around 75% in Norway and more than 50% in Switzerland and Canada. The spurt in the growth occurred post 2000 and continues to grow. Figure 5 depicts the rise in green box subsidies in Australia, Canada, Norway and Switzerland-Liechtenstein. Although Canada has also increased its green box support post 2000, it declined in 2009 but still remains much higher than the 1995 level in absolute terms.

2.2.3 Rising Green Box Subsidies in Other Developed Countries

The rising trend in domestic support measures in green box is not just limited to US and EU. Other developed countries have also increased their green box subsidies. The domestic support under green box has increased more than 150% in Australia, around 75% in Norway and more than 50% in Switzerland and Canada. The spurt in the growth occurred post 2000 and continues to grow. Figure 5 depicts the rise in green box subsidies in Australia, Canada, Norway and Switzerland-Liechtenstein. Although Canada has also increased its green box support post 2000, it declined in 2009 but still remains much higher than the 1995 level in absolute terms.

³ J.-C. Debar et A. Blogowski, *Les programmes d'aide alimentaire intérieure aux Etats-Unis*, Notes et études économiques, n°9, mars 1999, Ministère de l'Agriculture et de la Pêche, p.51-75

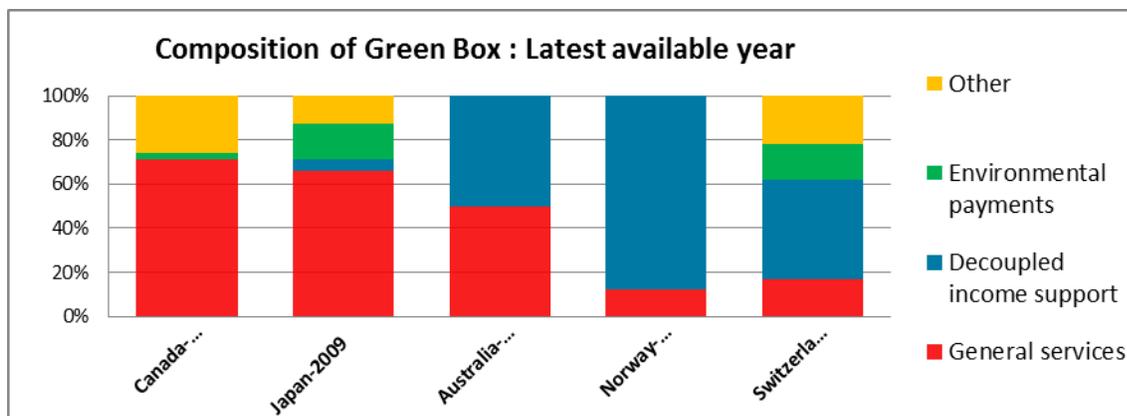
Figure 5: Rise in Domestic Support under Green Box: 1995-2010



Source: based on WTO Notifications: 1995-2010

Figure 6 illustrates the distribution of domestic support within green box for the latest available year in the above mentioned countries. General services have more than 60% share of green box subsidies in Canada and Japan and around 50% in Australia. Decoupled payments comprise around 88% of total domestic support under green box in Norway and around 45% in Switzerland-Liechtenstein.

Figure 6 Composition of Green Box in Selected Developed Countries



Source: based on WTO Notifications: 1995-2010

3. Existing Theoretical and Empirical Evidence of Production and Trade Distorting Impact of Green Box Subsidies

Although it has been accepted by the WTO members under the AoA that domestic support measures under green box are permitted as they do not or at most minimally distort production and trade, the growing trend towards "box-shifting" has led to a stream of theoretical and empirical literature which provides evidence to the contrary. This section provides a brief review of

theoretical literature, increasingly supported by empirical evidence, which shows that production decisions are not decoupled from domestic support measures permitted in in green box. There is also rising evidence that these domestic support measures are trade distorting.

It is well established in the theoretical literature that the channels through which the decoupled payments under green box can affect production. These are through (a) risk effects; (b) land price effects; (c) credit effects; (d) labour participation effects; and (e) expectations effect.

(a) **Risk effects** were first articulated prominently by Hennesy (1998), when he argued that decoupled payments can reduce the risks faced by farmers by increasing their wealth (wealth effect) and making them less risk-averse and therefore produce more. Risk effect can also work through insurance effect, which reduces the price risk faced by domestic producers and therefore lead to increased production. It has also been argued that risk effect can distort international trade by reducing the degree of adjustment in domestic markets, increasing world price variability and forcing greater adjustments in other countries. This can therefore lead to negative insurance effect on other countries' production and promote production and net trade in the country with decoupled payment support.

Empirical evidence of Risk effects of decoupled payments have been tested by many studies including Chavas and Holt (1990), Young and Westcott (2000), Anton and Le Mouel (2004), Sckokai and Moro (2006) Serra et al. (2006), Serra, Goodwin, and Featherstone (2011) and Just (2011). Brady et al (2009) found that decoupled payments increases land rental prices and this in turn affect future farm income and production decisions. Although most of the studies find that decoupled payments impact production by making farmers less risk-averse and affecting relative land prices, many argue that this effect may not be very large and can be termed as minimal. However, very few studies have actually estimated the elasticity of decoupled payments with respect to production.

b) **Land price effects** operates when the decoupled payments are capitalized into land values. Many studies have modeled this effect and its related implication for production and investments in agriculture. These include Roe, Somwaru, and Diao (2003), Roberts, Kirwan, and Hopkins (2003), Goodwin, Mishra, and Ortalo-Magne (2003), Kirwan (2009), Dewbre, Anton, and Thompson (2001) and Gohin (2006).

Empirical evidence of land price effects is steadily rising. Goodwin et al. (2003) found that decoupled payments have increased land values, ranging between 2 to 6 percent in the Northern Great Plains and Corn Belt regions. Barnard et al. (2001) found that the gap between aggregate land values with and without government payments was about 13 percent during 1990-97, increasing to about 25 percent during 1998-2001 when payments included market loss assistance and marketing loan benefits in addition to production flexibility contract payments in US. Studies have emphasized the heterogeneity of this impact across regions and forms of payments. For Northern Ireland, Patton et al (2008) estimated that the capitalization rate of *coupled* subsidies varied between 20% and 100%, whereas the capitalization rate of *decoupled* subsidies varied between 20% and 80%.

Woodard, Paulson, Baylis and Woodard (2010) using data from Illinois Farm Bureau Farm Management for 1996 to 2008 find capitalisation of 27 cents per dollar but when the sample is

divided into pre and post the 2002, capitalisation is found to be only 8 cents in the pre 2002 period and 47 cents post 2002 period. Hendricks, Janzen and Dhuyvetter (2012) use a panel dataset of Kansas farmers from 1990 to 2008 to estimate a dynamic rental equation using System GMM and find that the short-run capitalisation of subsidies into agricultural rents increases to 12 cents and long run increases to 37 cents per dollar of subsidies.

Using data for the German federal state of Lower Saxony in 2001, Breustedt and Habermann (2011) explore the incidence of EU per-hectare payments for eligible arable crop land and find that an additional euro of premium payments increases rents by 38 cents.

Ciaian and Kancs (2012) explore the capitalisation of Single Area Payment Scheme (SAPS) payments into land rents in the new EU Member States for 2004 and 2005. A first-difference estimator is used to remove the effects of time invariant omitted variables and selection bias is controlled for by including the Inverse Mills Ratio based on a probit model for whether the farm rents land. They find that between 18 and 20 cents per euro of SAPS payments are bid into land rents.

(c) **Credit effects** operate when domestic support measures under green box lower the cost of access to debt. Studies have argued that in presence of imperfect capital markets, including significant gap between borrowing and lending rates, any agricultural policy with respect to credit availability will affect farmers' willingness to invest generating additional production in future and will also potentially raise farmers' credit worthiness and liquidity (Rude, 1999, Phimister 1995).

Empirical evidence on credit effects of green box subsidies is difficult to estimate in terms of elasticities. Nevertheless, many studies show that investment is sensitive to cash flows and lower cost of credit can increase investments by farmers. These include Bierlen and Featherstone (1998), Bierlen et al. (1998), Gilchrist and Himmelberg (1995), Whited (1992), Hubbard et al. (1995), Rude (2000), Benjamin and Phimister (2002) and Vercaemmen, (2003). Westcott and Price (1999), estimated the effects of the marketing loan program on soybean production. They use the USDA 1999 baseline and simulated an econometric model for the US agricultural sector. The results show that soybean acreage increased due to marketing loans, resulting in higher production and lower prices. As a result of the acreage effects, exports of soybean oil were found to increase by 1-2 percent.

(d) **labour participation effects** occur and can affect production when farm households receiving decoupled payments accordingly allocate their labour between farm and non-farm activities. Studies show that decoupled payments induces farm households to spend more time on farm and increase production. These studies include Ahearn, El-Osta, and Dewbre (2006), El-Osta, Mishra, and Ahearn (2004) and Key and Roberts (2009).

(e) **Expectations effect** of subsidies under green box can affect production as farmers may alter their production decisions to maximize their future payments from expected policy changes (Lagerkvist 2005, Sumner 2003, McIntosh, et al 2007). Some studies like Coble et al (2008) have pointed out that the 2002 Farm Act, which extended the fixed decoupled payments of the 1996 Act, gave producers an opportunity to update their base acreage and yields, and allowed them to include acreage in common oilseeds like soybeans and rapeseed in their base. Prior to 2002, farmers may have altered planting decisions in anticipation of the base updating, even though

current payments were decoupled from current production. Decoupled payments can therefore affect farmer expectations by linking current decisions to future payments (Lagerkvist, 2005; McIntosh, Shogren and Dohlman, 2007; Coble, Miller and Hudson, 2008).

Empirical evidence of production and trade distorting effects of green box subsidies as a package has also been estimated by studies. Bakshi and Ker (2009) estimate the impact of Net Income Stabilization Account (NISA) and the Canadian Agricultural Income Stabilization (CAIS) in Canada under green box on production and trade. The estimated results show significant coefficients of expected total wealth and variance of total wealth which implies that the whole-farm programs are production and therefore trade distorting and are not actually decoupled. The estimated statistically significant coefficients (for expected total wealth and variance of total wealth variables) are then used to simulate the impact of the NISA and CAIS programs. The results show that NISA and CAIS programs increased the acreage allocated to spring wheat, rye and peas in the Prairie Provinces. During 1991-2002, spring wheat acres increased, mostly through the insurance effect, on average by 9.25 percent in Manitoba, 5.34 percent in Saskatchewan and 11.12 percent in Alberta under the NISA. Under the CAIS, spring wheat acres expanded during 2003-2006; on average by 14 percent in Manitoba, 10.67 percent in Saskatchewan and 8.90 percent in Alberta. In the NISA period, peas acres increased, through insurance effect, on average by 15.18 percent in Manitoba, 3.22 percent in Saskatchewan and 11.02 percent in Alberta. Based on the results, under CAIS, peas acreage increased by 23.82 percent in Manitoba.

Key et al. (2006) find that participation in government schemes, including the 1996 FAIR Act actually increased production levels among participants in the programme. The study compares program participants to nonparticipants that are otherwise similar in their observed characteristics and find that participants increased plantings of program crops by 38 to 59 percentage points more than nonparticipants.

4 Impact of Green Box Subsidies on Agricultural Productivity and Efficiency

While theoretical and empirical literature has emphasized implications of subsidies in green box on production and trade via wealth effects, insurance effects, land price effects, etc, there is another stream of literature which has emerged on estimating the impact of subsidies on agricultural production via its impact on productivity and efficiency. The main objective of categorizing selected domestic support measures under green box was that these measures do not or only at most minimally distort production and post-1995 efforts were made to decouple the payments from production under the green box. However, emerging empirical literature suggests that even the decoupled payments have led to substantive increases in farm output via increases in productivity and efficiency. This positive impact stems from investment-induced productivity gains caused by interaction of credit and risk attitudes with subsidies, especially in credit-starved farms (Rizov et al, 2013). Mary (2012) estimates the impact of various types of CAP subsidies on the productivity and efficiency of French crop farms for the period 1996–2003 and finds that the Agenda 2000 reform (i.e. partial decoupling) had a positive impact on aggregate productivity and led to increased production.

This section estimates the impact of green box subsidies on agriculture productivity and technical efficiency in 26 countries for the period 1995-2007⁴. WTO Notifications of the countries are used for arriving at extent of total domestic support measures in green box in each year for each country. Data Envelopment Analysis (DEA) is used to estimate the impact of green box subsidies on total factor productivity and cost efficiency.

DEA is a widely used technique for estimating the impact of subsidies on output. Using DEA methodology, a comparison of total factor productivity (TFP) across countries is undertaken with and without green box subsidies. DEA analysis also allows comparisons of the sources of productivity improvements across countries. It not only provides comparable percentage changes in productivity due to subsidies but also decomposes changes in TFP into changes due scale, changes due to technical improvements and those due to improvements in technical efficiency.

4.1 Methodology and Data

The paper uses Data Envelopment Analysis (DEA) for estimating the impact of green box subsidies of total factor productivity and technical efficiency. 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 assumed⁵. This paper assumes VRS technology and selects the output oriented 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 converse⁶. TFP is then calculated using a Malmquist TFP index, that is derived from a sequence of data envelopment analysis (DEA) frontiers that are fitted to the sample data in each of the year. For calculating cost efficiencies, however, this paper uses an input oriented approach. One advantage of using DEA is that DEA does not require a parametric specification of a functional form to define the frontier. This is critical to the analysis of impact of subsidies on productivity. Further, DEA allows considering multiple outputs along with multiple inputs and permits the relationship between all inputs and outputs simultaneously.

⁴Green Box subsidies are available for all countries till 2007, after that many countries have still not notified their domestic support under green box.

⁵Agricultural production is generally assumed to have variable returns to scale

⁶This has also been argued by Tim Coelli and Prasada Rao (2005).

There is a voluminous literature on impact of subsidies on output with the traditional approach being that subsidies reduce productivity and efficiency of agricultural production as their availability provides less motivation for improving efficiency. However, more recent studies show that subsidies can increase productivity by reducing risk aversion and costs of borrowing. Studies have argued that subsidies can increase productivity and technical efficiency if they provide incentive, financial or otherwise, to switch to new technologies (Harris and Trainor, 2005).

Three different modelling approaches have been used by the studies for estimating impact of subsidies on total factor productivity (TFP). First set of studies use subsidies as one of the traditional inputs in the production function (e.g., Zhengfei and Oude Lansink, 2006); second set of studies use a two-step method where productivity is estimated and then regressed on factors affecting productivity, with subsidies as being one of the factors (e.g., Stefanos et al 2012); third set of studies compare productivity growth in pre and post subsidies period (e.g., see Olson and Vu, 2009). The first two approaches have limitations. Using subsidies as an input suffers from the limitation that subsidies are treated as traditional input like land and labour but unlike traditional inputs, by themselves they may not be able to produce any output. Further, they are not necessary for production of output. In the second approach, although this limitation is taken care but this approach does not take into account the impact of subsidies on output via its impacts on input productivity, technical efficiency and technical change (see McCloud and Khumbhakar, 2008). Third approach has high probability of omitted variable bias.

The approach adopted in this analysis is to consider subsidies as an additional output along with the total agricultural output produced. Since these subsidies are decoupled from production, they are like additional incomes or wealth in the hands of the farmers in the form of decoupled payments, concessional loans, general services provided or risk covered which may be linked to ability to invest more. Comparison of TFP and technical efficiencies in agriculture is made with and without subsidies. Using subsidies as an additional output in DEA analysis to estimate its impact on productivity and efficiency has been used by recent studies (e.g., see Silva and Marote 2013).

The analyses undertaken can be divided into two parts. *First*, total factor productivity growth for 26 countries for the period 1995–2007 is estimated using Malmquist indices, which are defined by distance functions in DEA. One output (total agricultural 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 green box subsidies (GB) as an additional output along with total agricultural output with three inputs- land, labour and capital. Total factor productivity (TFP) is estimated using distance functions with and without GB as output. TFP is further decomposed into technical efficiency (TE) 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.

Two Outputs and three inputs are used for DEA. Outputs considered are: Agriculture, value added at constant 2005 US\$ (source- FAO); and Green Box Subsidies (source-WTO Notifications). Inputs considered are Arable land Area in 1000 Ha (source- FAO); Total economically active population in Agriculture (source FAO); and Gross Capital Stock in constant 2005 prices (source-FAO).

4.2 Average Green Box Subsidies and Total Factor Productivity Growth (TFPG): 1995-2010

In the period 1995-2007, total green box subsidies for 26 countries were recorded as \$ 2.6 trillion, of which 41% (\$ 1.07 trillion) were given by USA and 27% (\$ 711.8 billion) by European Union (EU). On an average, \$ 6.4 billion of subsidies were provided under green box every year. USA has provided \$67.1 billion every year while EU has provided green box subsidies worth \$44.4 billion per annum in the period 1995-2010. High GB countries (with subsidies greater than average) include USA, EU, China and Japan. Medium GB countries (with subsidies greater than \$1billion average pa) include Korea, Republic of, Switzerland-Liechtenstein, Canada, Brazil, Australia and Thailand, while the rest can be categorized as low GB countries (Table 1). While green box subsidies increased substantially in USA and EU in 2007 as compared to 1995, it has declined in Japan and many developing countries including Brazil, Thailand, Mexico, Cuba, Malaysia, Chile, Israel and Namibia.

Table 1: Average Green Box Subsidies in Selected Countries: 1995-2007 (Based on WTO Notifications)

S.No		Country	Average GB Subsidies (US \$ Million)	GB Subsidies in 1995 (US\$ Million)	GB Subsidies in 2007
1	High GB	United States of America	67'107	46'041	76'162
2	High GB	European Union	44'493	25'022	85'795
3	High GB	China	23'626		36'785
4	High GB	Japan	20'739	33'908	15'999
5	Medium GB	Korea, Republic of	4'974	5'187	5'742
6	Medium GB	Switzerland-Liechtenstein	2'667	2'304	3'000
7	Medium GB	Canada	1'982	1'529	2'977
8	Medium GB	Brazil	1'525	5'061	1'207
9	Medium GB	Australia	1'245	690	2'325
10	Medium GB	Thailand	1'119	1'352	1'081
11	LoW GB	Norway	762	648	1'149
12	LoW GB	Mexico	570	791	627
13	LoW GB	Indonesia	567	160	902
14	LoW GB	Cuba	556	908	118
15	LoW GB	Morocco	343	292	733
16	LoW GB	Malaysia	216	243	222
17	LoW GB	New Zealand	169	133	253
18	LoW GB	Chile	160	307	198
19	LoW GB	Israel	78	97	77
20	LoW GB	Tunisia	46	29	50
21	LoW GB	Dominican Republic	43	6	54
22	LoW GB	Namibia	21	50	27
23	LoW GB	South Africa	0.8	0.8	1.3
24	LoW GB	Costa Rica	0.2	0.4	0.1
25	LoW GB	Colombia	0.1	0.3	0.1
26	LoW GB	Paraguay	0.0	0.0	0.0
		Grand Average	6'414		

4.3 Impact of Green Box Subsidies on Total Factor Productivity: Results

Table 2 reports the results of DEA analysis estimating the impact of green box subsidies on total factor productivity growth in agriculture and improvements in technical efficiency. As discussed above, even subsidies which are decoupled from production (which is the underlying principle in categorising subsidies under green box), may affect production through many channels like creation of wealth effect, lowering risk aversion, lowering cost of credit and inducing investments, etc. This comes out clearly in the results as countries which experienced a rise in their green box subsidies in the period 1995-2007, also experienced a rise in their total factor productivity and technical efficiency scores. Change in the scores with and without green box subsidies show the extent to which productivity and efficiency in agriculture has increased due to green box subsidies.

Maximum increase in green box subsidies has been experienced by EU, as the results show that total factor productivity growth in agriculture is 3.7% per annum without GB subsidies but it increased to 8.3% per annum due to GB subsidies. A rise of on an average 4.6 percentage points per annum in agriculture productivity can be attributed to green box subsidies in EU in the period 1995-2007. For USA, the increase in GB subsidies was \$30 billion in this period, which increased total factor productivity from 2.6% per annum to 6.8% per annum, an increase of on an average 3.9 percentage points per annum. This implies that over 13 years, agricultural productivity has increased around 60% in EU and 51% in USA on account of green box subsidies. This result corroborates the survey results arrived at by (FAL) German Federal Agricultural Research Centre (FAL) in 2005 on a sample of farms in Germany, which showed that the investment aids provided increased the productivity of the farms by 40-73%.

Similar increases in agricultural productivity are seen in case of Canada, Norway and Switzerland, although technical efficiency has not increased substantially in these countries. However, productivity may not rise for all countries with increase in green box subsidies. In Australia, although there is a rise in GB subsidies, TFP has actually declined. In EU decoupled income support is a large part of direct payments (almost 50%) while in Australia it is a small fraction of direct payments.

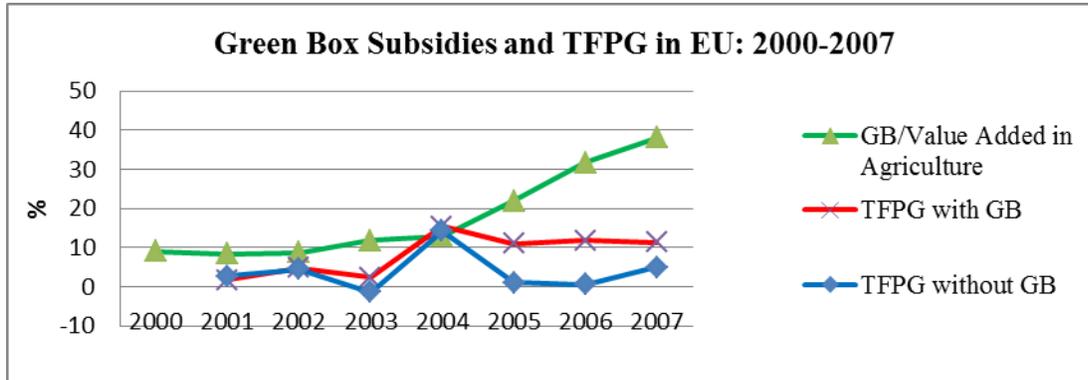
Table 2: Change in Total Factor Productivity and Technical Efficiency in Agriculture due to Green Box Subsidies

COUNTRY	Change in GB in US\$ Million (1995-2007)	Total Factor Productivity without GB Subsidies	Total Factor Productivity with GB Subsidies	Average Per Annum Change in Total Factor Productivity due to GB Subsidies (%)	Average Per Annum Change in Technical Efficiency due to GB Subsidies (%)
Australia	1'635	1.031	1.029	-0.2	-0.2
Brazil	-3'854	1.037	1.037	0	0
Canada	1'448	1.029	1.048	1.9	1
Chile	-109	1.061	1.061	0	0
China	23'605	1.042	1.045	0.3	0.1
Colombia	0	1.104	1.104	0	0
Costa Rica	0	1.129	1.129	0	0
Cuba	-790	1.008	0.875	-13.3	-15.8
Dominican Republic	47	1.071	1.061	-1	0
European Union	60'772	1.037	1.083	4.6	4.8
Indonesia	741	1.019	1.019	0	0
Israel	-20	1.042	1.042	0	0
Japan	-17'910	1.003	0.985	-1.8	-2.3
Korea, Republic of	555	0.998	1.002	0.4	0
Malaysia	-21	1.228	1.228	0	0
Mexico	-164	1.051	1.051	0	0
Morocco	441	1.565	1.578	1.3	0.03
Namibia	-23	1.003	1.003	0	0
New Zealand	121	1.081	1.081	0	0
Norway	501	1.175	1.191	1.6	-1.8
Paraguay	0	1.055	1.055	0	0
South Africa	1	1.004	1.004	0	0
Switzerland-Liechtenstein	696	1.004	1.038	3.4	0
Thailand	-271	1.021	1.016	-0.5	0
Tunisia	21	1.016	1.016	0	0
United States of America	30'121	1.023	1.062	3.9	2.5

Estimating year to year agricultural productivity change in EU estimated by DEA, we find that green box as a proportion of total value added in agriculture increased from less than 10% in 2000 to 38% in 2007 pulling up total factor productivity growth from 2.7% in 2001 to 11.4% in 2007, while this would have been at 5% in 2007 (Figure 7). Post 2003 reforms, green box has contributed more to agriculture productivity as compared to earlier CAP programs. In 2014-2020,

planned green box subsidies are much higher and therefore will have greater impact on productivity and thereby agricultural production.

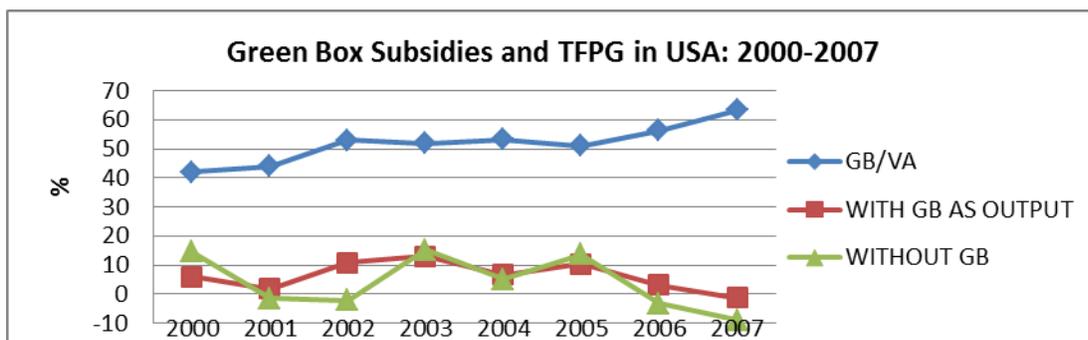
Figure 7: Total Factor Productivity Growth in Agriculture Production with and without GB in EU: 2000-2007



Source: Based on WTO Notifications and FAO

Similar analysis of year-year growth in agricultural productivity shows that in USA green box subsidies as a ratio of total value added in agriculture increased from 42% in 2000 to 63% in 2007. While this ratio remained between 53% to 51% in the period 2002-2005, total factor productivity growth increased from -2.1 % in 2002 without green box support to 10.7% with green box support. In 2007, productivity growth without GB would have been -8.9% but with the support it was -1.3%. The spurt in green box subsidies post 2005, helped in sustaining productivity growth in USA post 2005.

Figure 8: Total Factor Productivity Growth in Agriculture Production with and without GB in USA: 2000-2007



Source: Based on WTO Notifications and FAO

5. Impact of Green Box Subsidies on Production and International Trade: Simulation Results

The impact of green box subsidies on production, export and import volumes, export revenues and import costs is estimated using The Agricultural Trade Policy Simulation Model (ATPSM) model, which is a trade policy simulation model for quantifying the economic effects of trade policy changes at the global and regional levels. Although this model was developed to estimate trade policy changes with respect to tariff cuts, amber box subsidy reduction and other trade policy simulations, the model has been suitably modified to estimate the impact of reduction in green box subsidies on aggregate agricultural production and trade. ATPSM version 3.1 (January 2006)⁷ has been used and the data for aggregate production and trade has been updated using average of 2005-2007, from FAO stats. The model covers 176 countries and others are included in the Rest of World category. The economy of each country is represented individually, except the 15 countries that are part of European Union which are represented as a single country group.

To undertake simulations of removal of GB subsidies, the cuts are applied to aggregate category comprising all commodities and impact on total production and total trade is estimated. Two kinds of simulations have been undertaken to quantify the impact of cut in green box subsidies of EU and USA, as they comprise bulk share of GB subsidies.

In 2007, GB subsidies of USA were \$76 billion, of which around 70% were food stamps. Removing food stamps from GB subsidies, 30% cut to total green box subsidies can be applied. However, using the estimates of "net equivalent support of food stamps to agricultural production" (as discussed above Debar and Blogowski, 1999), which is approx. 10%; a cut of 40% to green box subsidies of USA is applied. For EU, decoupled payments amounted 50% of total green box subsidies in 2007, therefore a cut of 50% is applied to green box subsidies. The first simulation results show the impact of 40% cut in GB subsidies of USA and 50% cut in GB subsidies of EU. The second simulation has been carried out using a capping of GB subsidies of USA and EU to their 2001 level, after which there was a surge in box-shifting.

The results of first simulation- cutting green box subsidies by 40% in USA and 50% in EU- on agricultural production and trade at regional level are reported in Table 4. The results show that these cuts could lead to major restructuring of agricultural production and trade where production and exports shift towards more competitive producers in developing countries. Imports will rise in developed countries by 22% while production will fall by 5%, contrary to this, exports of developing countries rise by 12% and export revenue increases by 17%. There is a fall in import cost and import volumes in developing regions.

Least developed countries do not experience a rise in their import costs, as has been argued many times in support of green box subsidies. In fact, export volumes increase from LDCs by 9% and export revenue increases by 8% while imports fall by 4%. Net food importing countries are also not unfavourably affected as their import costs fall and export revenue rise as non-food

⁷ ATPSM is a deterministic, partial equilibrium, comparative static model. It analyses the effects of price and trade policy changes on supply and demand using a system of simultaneous equations that are characterized by a number of data and behavioural relationships designed to simulate the real world. The model solution gives estimates of the changes in trade volumes, prices and welfare indicators associated with changes in the trade policy environment.

agricultural exports from these countries increase. Import volumes of agricultural products rise substantially in EU (35%) and USA (67%) along with import costs. North Africa and Middle East appear to gain most in terms of percentage change in volume of exports but this may be because of their lower base. There is a rise of 6% in export volumes and export revenue in Sub-Saharan Africa.

The results show that production and trade distorting impact of green box subsidies is not minimal as even a cut of 40%-50% in just two countries leads to increase in global trade volume by 5% and trade revenues by 8%, with average increase in export revenues of more than 15% for developing countries. The results for LDCs are starker as this can lead to increase in their trade revenues between 10%-17% without increasing their import costs.

Table 4: Simulations Results of capping of Green Box Subsidies in 2007: 50% cut in EU and 40% cut in USA Green Box subsidies

	Percentage Change in Production	Percentage Change in Export Volumes	Percentage Change in Import Volumes	Percentage Change in Export Revenue	Percentage Change in Import Cost
Central America	1%	3%	-5%	3%	-4%
Caribbean	1%	5%	-3%	8%	-0.5%
Central Asia	2%	18%	-8%	21%	-3%
Central and Eastern Europe	2%	14%	-13%	18%	-4%
Developed Countries	-5%	-1%	22%	2%	22
Developing Countries	1%	12%	-5%	17%	-4%
Least Developed Countries	1%	10%	-4%	10%	-1%
Net Food Importing Countries ⁸	1%	19%	-4%	24%	-3%
North Africa and Middle East	2%	29%	-3%	47%	-0.1%
North America	-4%	-2%	42%	0%	33%
Oceania	2%	6%	-4%	9%	5%
South America	1%	7%	-8%	13%	-7%
Sub Saharan Africa	1%	6%	-2%	6%	-0.3%
Western Europe	-8%	-3%	33%	-2%	34%
European Union	-8%	-4%	35%	-3%	36%
USA	-5%	-4%	67%	-2%	43%
World	-1%	5%	5%	8%	8%

Source: Author's estimations based on ATPSM

⁸ As per the list of Committee on Agriculture, WTO-G/AG/5/Rev.10

Results of second simulation, i.e., capping of GB subsidies of USA and EU to 2001 level, are reported in Table 5. This is undertaken to estimate the extent of distortions caused by green box subsidies in global agricultural production and agricultural trade post 2001. The GB subsidies in USA increased from \$50 billion in 2001 to \$120 billion in 2010 while that of EU rose from \$18 billion to \$90 billion.

The results show that such a capping will result in substantial gains to developing countries as well as LDCs and Net Food Importing Countries (NFIC) in terms of agriculture production and trade. Agriculture production shifts towards more competitive producers and it increases by 3%-5% in developing regions while export revenues increase by 55% in developing countries and 32% in LDCs. NFIC increase production of agricultural products (not necessary food) by 4% and their export revenues increase by 81% (probably because of low base) while import costs decline by 4%. Global agriculture production increases by 3% while export volume increase by 17% and export revenue by 25%. All developing regions experience a fall in their import costs as production shifts to more competitive and lower cost producers while imports of developed regions rise substantially. This indicates the extent of artificial competitiveness created because of subsidies in developed countries. Agricultural production in US falls by 15% while that of EU falls by 19% while their agricultural imports rise by 200% and 85% respectively. Rise in import costs are lower than rise in import volumes, which can be taken as indicative of cheaper imports in these countries.

Table 5: Simulations Results of capping of Green Box Subsidies at 2001 Level in EU and US

	Percentage Change in Production	Percentage Change in Export Volumes	Percentage Change in Import Volumes	Percentage Change in Export Revenue	Percentage Change in Import Cost
Central America	4%	10%	-14%	11%	-10%
Caribbean	1%	17%	-8%	25%	0%
Central Asia	5%	53%	-17%	65%	-5%
Central and Eastern Europe	6%	69%	-22%	76%	-8%
Developed Countries	-14%	3%	64%	5%	65%
Developing Countries	3%	41%	-10%	55%	-6%
Least Developed Countries	3%	33%	-8%	32%	-1%
Net Food Importing Countries	4%	67%	-10%	81%	-4%
North Africa and Middle East	5%	90%	-8%	145%	1%
North America	-13%	5%	158%	-1%	114%
Oceania	5%	17%	-9%	27%	14%
South America	4%	23%	-13%	42%	-9%
Sub Saharan Africa	3%	23%	-5%	19%	0%
Western Europe	-19%	8%	80%	-5%	85%
European Union	-19%	-10%	85%	-8%	91%
USA	-15%	-10%	226%	-8%	149%
World	3%	17%	17%	25%	25%

6. Stronger International Disciplines on Green Box are needed

Green Box subsidies as they stand in the Agreement of Agriculture must have no or at most minimal trade or production distorting effects. Although developed countries have over the years attempted to decouple their domestic support in green box from production, they have increasingly coupled them with the producers' behavior. Box shifting in the developed countries has substantially increased the amount of subsidies in green box. The sheer volume and nature of subsidies provided by some of the developed countries, especially EU and USA, have led to significant production and trade distortions. These subsidies operate by influencing producers' decisions with respect to current production volumes and sales by lowering their costs of production, increasing their wealth, lowering their risks of investments and creating domestic demand for their products. Growing theoretical as well as empirical literature on production and trade distorting impacts of green box subsidies has been largely ignored till date.

There have been many unsuccessful efforts in the past to reopen and redefine the criteria on green box in order to make the subsidies listed in Annex 2 meet the criteria of the annex's first paragraph. Chair's overview paper in 2002 (TN/AG/6, 18 December 2006) based on proposals received on possible changes in the provisions green box and comments of G-20 (JOB (06)/145, May 16, 2006) on the review paper reports the proposed changes. Subsidies debated under green box include direct payments to the producers (paragraph 5), including decoupled income support (paragraph 6) and government financial support for income insurance and income safety-net programmes (paragraph 7). It has also been pointed out by the G-33 proposal that price support for small resource poor farmers for public food stockholding programmes should be shifted to Green Box subsidies that are allowed without limits. Further, a new green box category has been suggested for developing countries to cater to their programs on poverty alleviation, rural development, food security, agriculture diversification and provision of employment opportunities.

In the Bali Ministerial meeting in December 2013, members have agreed to prepare a work programme for concluding Doha Round. A group of issues that have been identified as 'easier to settle' for building the momentum include issues in export competition; tariff quotas; developing countries' food stockholding for food security; and a proposed list of general services of particular interest to developing countries that would be added to the green box. There is a need to bring 'revision of the provisions in green box' into the Post Bali work program. The new CAP in EU (2014-2020) and Farm Bill 2014 in USA have substantially increased their domestic support measures in direct payments and other categories of green box. This can lead to significant distortions in world production and international trade in agriculture, adversely impacting the more efficient and small producers in developing countries. In 2007, around 70% of total green box subsidies were provided by EU and USA.

It has sometimes been argued that green box subsidies in developed countries should be limited to low income farmers, however given the way these subsidies are now being designed, it may not be possible to distinguish between those subsidies under green box which reach low income farmers and those which benefit high-income farmers.

Based on the empirical evidence and arguments on production and trade distorting impact of green box subsidies, which by no means are minimal, the provisions under green box need to be revisited. Green box subsidies need to be disciplined.

Some of the broad principles that can be followed include

- a) Capping total green box expenditures of developed countries- There is a need to identify an upper bound for the extent of subsidies that can be provided by developed countries under the green box. This is important for avoiding any further box shifting.
- b) Limit or completely eliminate subsidies provided under decoupled payments- as these payments will necessarily be coupled, either directly or indirectly, and will support production which may not otherwise be economically viable.
- c) Allow direct payments only in case of natural disasters and/or otherwise where production loss has been above a threshold level.
- d) Structural adjustments programs have to be time-limited- else they may lead to cumulative production and trade distorting impacts.
- e) Strengthen the review mechanism to ensure that expenditures categorized under green box satisfy the basic principle of Annex 2.

7. Summary and Conclusions

Agricultural subsidies and their impact on production, trade and international competitiveness of developed countries has been a contentious issue in multilateral negotiations since the early 1980s. An important step was taken during the Uruguay Round to bring these subsidies under the ambit of international disciplines in the Agreement on Agriculture (AoA). The idea of exempting production and trade-neutral subsidies from WTO commitments was first proposed by US in 1987 and subsequently endorsed by EU. These subsidies were categorized under the Green Box (GB).

Following the AoA, there has been a significant reduction in subsidies under Amber box and Blue box in the developed countries. However, this decline has been more than compensated by substantial increases in green box domestic subsidies following extensive "box-shifting" of subsidies. USA increased its GB subsidies from \$46 billion in 1995 to \$120 billion in 2010; while EU's GB subsidies increased from € 9.2 billion to € 68 billion. GB subsidies have increased more than 150% in Australia, around 75% in Norway and more than 50% in Switzerland and Canada in the period 1995-2010. The spurt in the growth of GB subsidies has occurred post 2000 and continues to grow.

Literature provides sufficient evidence on the favourable impact of GB subsidies on production and competitiveness of the developed countries. This paper adds to the existing literature by estimating the impact of GB subsidies on agricultural productivity and technical efficiency in 26 countries in the period 1995-2010. Results of Data Envelopment Analysis (DEA) show that in EU, total factor productivity growth in agriculture would have been 3.7% per annum in this period without GB subsidies but it increased to 8.3% per annum due to GB subsidies. For USA, total factor productivity growth increased from 2.6% per annum to 6.8% per annum, an increase of on an average 3.9 percentage points per annum due to GB subsidies. This implies that over 13 years, agricultural productivity has increased around 60% in EU and 51% in USA on account of green box subsidies.

Estimating year to year agricultural productivity change in EU, DEA results show that GB subsidies as a proportion of total value added in agriculture increased from less than 10% in 2000 to 38% in 2007, which raised total factor productivity growth from 5% to 11.4% in 2007. Similar analysis shows that in USA GB subsidies as a ratio of total value added in agriculture increased from 42% in 2000 to 63% in 2007. Total factor productivity growth increased from -2.1 % in 2002 without green box support to 10.7% with green box support. In 2007, productivity growth without GB would have been -8.9% but with the GB support it was -1.3%. The spurt in GB subsidies post 2005, helped in sustaining productivity growth in USA.

The impact of green box subsidies on production, export and import volumes, export revenues and import costs is estimated using the Agricultural Trade Policy Simulation Model (ATPSM version 3.1, January 2006). The data for aggregate production and trade has been updated using average of 2005-2007, from FAO stats. The results of first simulation, i.e., cutting green box subsidies by 40% in USA (excluding food stamps) and 50% in EU (de-coupled payments) show that these cuts could lead to major restructuring of agricultural production and trade where production and exports shift towards more competitive producers in developing countries. Following the cuts, imports rise in developed countries by 22% while production falls by 5%, contrary to this, exports of developing countries rise by 12% and export revenue increases by 17%. Least developed countries do not experience any rise in their import costs; in fact, export volume and export revenue increase in LDCs by 9% and 8% respectively, while imports fall by 4%. Net food importing countries are also not unfavourably affected as their import costs fall.

Results of second simulation, i.e., capping of GB subsidies of USA and EU to 2001 level show that such a capping will result in substantial gains to developing countries as well as LDCs and Net Food Importing Countries (NFIC) in terms of agriculture production and trade. Agriculture production increases by 3%-5% in developing regions while export revenues increase by 55% in developing countries and 32% in LDCs. NFIC increase production of agricultural products (not necessary food) by 4% while import costs decline by 4%. Global agriculture production increases by 3% while export volume and revenues increase by 17% and 25% respectively. These results indicate the extent of artificial competitiveness created because of subsidies in the developed countries. Agricultural production in USA falls by 15% while that of EU falls by 19% while their agricultural imports rise by 200% and 85% respectively. Rise in import costs are lower than rise in import volumes, which can also be taken as indicative of cheaper imports in these countries.

In view of the growing literature and empirical evidence on production and trade distorting impact of Green Box subsidies of developed countries, which are substantial in volume, it is important to bring GB subsidies under international disciplines and cap them in order to avoid further box shifting. There is a strong case for giving priority to disciplining Green Box subsidies in the post Bali work program. Some of the broad principles suggested by the paper for disciplining GB subsidies include- capping total green box expenditures of developed countries; limiting or completely eliminating subsidies provided under decoupled payments; allowing direct payments only in case of natural disasters and/or otherwise where production loss has been above a threshold level; making structural adjustments programs time bound; and strengthening the review mechanism to ensure that expenditures categorized under green box satisfy the basic principle of being minimally production and trade distorting.

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