Impact of Farm Subsidy on US Export: A Panel Study at State Level

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Abstract

Because the US is the leading exporter in agriculture, its domestic subsidies have caused huge controversy among World Trade Organization (WTO) members. We investigate the impact of US subsidization on its exports using panel data at the state level. The estimate from the modern gravity model shows that a 1% decrease in subsidy would reduce US exports by 0.13%. This means that removal of agricultural subsidy will lead to more than a $50 billion reduction in US export value per annum. Importantly, this effect is found when the endogeneity of subsidy policy is taken into account. In addition, the impact of subsidy is consistent and sensible when we closely look into the effect of different types of program payments and different farm bills. Furthermore, the substantial impact of subsidy on domestic production as a primary economic channel of the trade-distorting effect has been uncovered.
Key words: Farm subsidies, farm bill, gravity equation, US exports

1. Introduction

Disciplines for market access, including domestic subsidies, export subsidies, and tariffs in agricultural sectors, are at the center of the ongoing Doha Rounds launched in 2001. Trade liberalization has gained substantial momentum since promulgation of the General Agreement on Tariffs and Trade (GATT) in 1947, as trade barriers have been successfully brought down by negotiations through a series of trade rounds. However, because of its extremely contentious feature, the agricultural sector was ignored until the Uruguay Round in 1986 and did not receive adequate attention until establishment of the World Trade Organization (WTO) in 1995. Consequently, global trade in agriculture is considered underdeveloped because trade barriers in this sector are substantially higher than those in other sectors. For example, the average applied import tariff rate for all merchandise is 5.2%, while this figure for agriculture is 16.7%. In addition, the export subsidies and domestic subsidies that have been frequently implemented by developed countries come at the expense of the competitiveness of producers in developing countries for whom agriculture is the main source of livelihood. Removal of trade distortions would benefit these countries through efficiency gains in resource allocation and terms of trade improvements (Hertel and Keeney, 2006). Yet, economists agree that among the three pillars of market access, tariffs exert the most important impact on trade while the impact of export and domestic subsidies is relatively small. Nonetheless, disciplines for subsidies are as important as disciplines for tariffs to avoid using them as an alternative tool once tariff barriers are reduced (Anderson and Martin, 2005).

The common understanding is that if a market satisfies the perfect competition condition and subsidies are paid on the quantity of production, the supply curve simply shifts to the right under the subsidy effect. The equilibrium hence moves to the right and production increases proportionally as a result. The extra production promotes exports or substitutes for imports depending on whether the country is a net importer or a net exporter of the subsidized commodity. In the case of imperfect competition, a subsidy boosts production by shifting the output reaction function outward as it helps to reduce the marginal cost of production. Hence, the domestic subsidized firm captures a larger share of the international market than it would otherwise (Brander and Spencer, 1985). For that reason, a subsidy attracts criticism because it renders the game unfair by changing the competitive advantage. More importantly, with a large economy such as the United States (US) or European Union (EU), subsidies may induce excessive production sufficiently large to depress the world price, thereby helping those large economies with an even higher position in international market rivalry.

Agricultural subsidies are mainly used by rich nations, with 88% of the total support coming from Organization for Economic Cooperation and Development (OECD) countries, while the remaining proportion is granted by some developing countries (Hoekman et al., 2004). If the EU and Japan are well known for their export subsidy, the US is prominent for its domestic payments. The US has experienced a long history of producer support since the 1930s when financial support was granted to farmers to help overcome the Great Depression. Since then, farm subsidies have become a permanent component of agricultural and food policies, providing farmers with a safety net by reducing the risk of price volatility. The most important subsidy programs in the US include price support, loan rate payments, and payments based on crop area. Although price support was more important and initially accounted for a large US budget outlay, there has been a shift to "decoupled" payments to conform to WTO disciplines.

A number of studies has assessed the impact of domestic subsidies on exports, imports, and welfare changes. Among them, Hertel and Keeney (2006) and Diao et al. (2001) estimate the impact of farm subsidies on global import and export values and welfare in comparison with the effect of tariffs. Meanwhile, Hoekman et al. (2004) and Dimaranan et al. (2003) shed light on the impact of agricultural support reform in developed countries on developing countries. Koo and Kennedy (2006) compare the impact on global price, export, and welfare of border support typically carried out by the EU and the impact of domestic support frequently undertaken by the US. Dewbre et al. (2001) and Dewbre and Short (2002) evaluate the impact of different subsidy programs, specifically, market price support, output payments, area payments, and variable input payments, used by OECD countries on trade in addition to production and income. The results show that purchased input support is the most trade-distorting, followed by market price support, with output payments coming third. The least trade-distorting is area payments, while historical payments are assumed to have no effect on trade.

The key objective of this study is to empirically investigate the impact of US domestic subsidies on its exports. The substantial variation in subsidy receipt among states for the reasonably long period of 13 years enables us to infer causal effects. In particular, some states, such as Rhode Island, New Hampshire, Hawaii, Nevada, Connecticut, and Massachusetts, receive a modest amount of support. In contrast, Illinois, Iowa, and Texas receive the largest subsidy support. Subsidy payments for the former group account for only 0.23% of all payments, while that figure is 27.5% for the latter. In addition, within-state variation is also large, allowing us to utilize state fixed effect to tackle the problem of endogeneity caused by subsidy policy. Therefore, the US presents a unique setting that exhibits extremely useful across and within-state variation that enables the identification of causal effects of agricultural subsidies on exports. Furthermore, the US is the world's largest exporter in the agricultural sector and at the same time the world's leading user of domestic support. Therefore, the extent to which US subsidization affects trade is the most important question for policy makers and trade negotiators in the setting of the Doha Development Agenda.

This paper makes several innovative contributions to the related literature. First, we address the problem of potential endogeneity of the subsidy policy by utilizing panel data. The exogeneity of policy has been questioned by many researchers. For example, Baier and Bergstrand, among others, argue that free trade agreements (FTAs) between two parties are endogenous to their bilateral trade flow. Trade value between two trading partners is quintupled when the endogeneity of FTAs is taken into account. Second, we identify exactly what programs cause trade distortion. This is an important response to the WTO discipline suggesting that more than minimal production and trade-distorting programs need to be cut. Another key point is that we shed light on the tendency of subsidy effects on exports over farm bills. This is particularly meaningful in that the US committed to phasing out domestic subsidies on a specific schedule and hence its subsidization policy reform has been watched out. Finally, we uncover the primary economic channel through which domestic support promotes trade by providing insight into its effect on domestic production. Estimates of the subsidy effect on production with various aggregation levels of outcome largely agree with those in the trade equation.

Our results document a meaningful and consistent impact of US domestic subsidies on its exports. After taking into account the potential endogeneity problem, our estimates suggest that a one percentage point decrease in subsidy payments leads to a 0.13%-0.14% decline in farm exports, which is equivalent to a more than $50 billion reduction in exports per annum. Importantly, detailed data on subsidy payment categories enable us to identify exactly what programs distort trade. Program payments that relate to market condition, current production, or price support are the major cause of the impact. Meanwhile, a stronger export promotion effect is confirmed among the commodities and crops for which subsidy payments are most concentrated. Moreover, Farm Bill 1996, which divorced payments from current production and market condition, seems to have had the lightest effect on domestic outputs and exports. Equivalently, making a contingent market price program (counter-cyclical payment) a formal component of Farm Bill 2002 created a higher distorting effect of subsidy on production and export. Furthermore, although the impact of subsidies on export appears to have declined in recent years (since Farm Bill 2008), there is no evidence of this reduction's impact on production. This suggests that the smaller impact of subsidies on exports is not a result of the intended subsidy policy itself, but instead may come from other instruments that direct extra production induced by farm subsidies to domestic markets rather than world markets.

The rest of the paper is organized as follows. Section 2 provides information on US farm bill and subsidy categorization. Section 3 presents the data and descriptive statistics, and Section 4 describes the empirical framework. Section 5 discusses the empirical findings and robustness check. Finally Section 6 concludes.

2. US Farm Bill and Subsidy Categorization

a. Overview of US Farm Bills throughout the Sample Period

The support levels and support provisions of the US federal government for agricultural producers have been institutionalized in farm bills that are revised and updated every five years. The Federal Agriculture Improvement and Reform Act of 1996 (FAIR Act), known as the "production flexibility contract," marked the most significant changes during this decade. Producers could freely plant crops except fruits and vegetables to be eligible for support. Moreover, subsidy payments were divorced from current production as the support calculation was based on historical production known as base acreage and yield. The poor market conditions from 1998 through 2000, however, triggered an ad hoc market loss assistance payment. This program later became an official payment after the Farm Bill 2002 under the name of counter-cyclical payments (CCPs). In addition, soybeans and other oilseeds were added as "covered commodities" in the Farm Security and Rural Investment (FRSI) Act of 2002.[1] Also, farmers were allowed to change their reference period for base acreage and yield in the FRSI Act. Critics have argued that the opportunity to update base acreage may trigger current production if farmers

[1] See section b for more detail about commodities that receive payments.

expect a similar updated base acreage and yield in the future. The Farm Bill 2008 continued the previous farm bill with small adjustments in the subsidy rate for eligible crops. In addition, the average crop revenue election (ACAE), which is triggered when revenue falls below a threshold, was introduced. Farmers can choose to enroll in either ACAE or CCP, but not both.

b. US Categorization of Subsidies

The US farm subsidies are categorized into four programs: commodity, crop insurance, disaster payment, and conservation reserve. The commodity program is the largest and most important category, accounting for two thirds of total farm subsidies. This program includes direct payments (DPs), CCPs,[2] and marketing assistance loans (MLs) for crops and payments for dairy and sugar. Commodities eligible for DPs and CCPs are called "covered commodities" and include wheat, corn, grain sorghum, barley, oats, upland cotton, rice, and pulse crops. Meanwhile, "loan commodities," which include covered commodities plus extra long staple cotton, wool, mohair, honey, dried peas, lentils, and small chickpeas, refer to commodities for which marketing assistance loans apply. To be eligible for commodity payments, farmers must "actively engage in farming," meaning they must share the risks of producing crops. In addition, farmers must comply with certain environmental and land conservation measures, as well as planting flexibility rules. The DP is granted to covered commodities (except pulse crops) plus peanuts with a fixed rate based on historical entitlement. The CCP is delivered to covered commodities on base acreage similar to the DP; however, it is triggered when the market price (or revenue if referring to ACAE, which was introduced in the Farm Bill 2008) falls below the setting price in the statute. Meanwhile, ML provides farmers with interim financing and if market prices drop below the loan prices set in the statute, additional income supports are granted as loan deficiency payments (LDPs). Market loans are nonrecourse loans that allow farmers to borrow cash using their harvested crops as collateral when market prices of crops are low. Alternatively, if farmers sell their commodities at a price lower than the setting loan price in the statute, they will receive support for the gap between the loan prices and market prices. Unlike DPs and CCPs, which are "decoupled" from production, MLs are linked to both market price and current production.

[2] From 1996 to 2002, the name production flexibility contract (PFC) and market loss assistant payment (MLA) were used for DP and CCP, respectively

Crop insurance programs help to reduce losses due to natural disasters and weather-related diseases. For insurable crops, farmers can choose to insure the yield level alone (for yield insurance), or they can choose the revenue level (yield times price) and pay a premium for the chosen level. The US government has spent an increasing amount of money for these programs with the hope that they can replace ad hoc disaster payments. These annual payments were $500 million in the 1980s, doubled after a decade, and since 2000 they have cost approximately $3.3 billion per annum. The majority of this fund is paid to farmers to support their payments for insurance coverage; approximately 370 crops and 80% of planted acreage in 2004 had insurance coverage.

Supplementing the crop insurance, disaster payments provide support to relieve losses on crops or livestock that are not eligible for crop insurance. If a crop experiences a loss of at least 50% compared with historical production, 55% of the market price payment for such crop will be granted. Although sharing a common purpose with crop insurance to help farmers with financial recovery, disaster payments are granted after losses occur.

Finally, conservation reserve programs (CRPs) are delivered to encourage farmers to retire erodible lands. To receive payments, farmers must remove low-quality land from production and plant species that help to improve land quality and health.

c. US Subsidy Payments: Amber vs. Green Box Categories

In WTO terminology, agricultural domestic subsidies are classified into three boxes: amber, blue, and green. Amber box supports are those relating to price support or production promotion and hence distort trade. An amber box payment becomes a blue box payment if it is accompanied by restrictions on production that can offset production stimulation to a reasonable degree. Meanwhile, a green box payment provides at most minimal trade and production distortion. Under WTO disciplines, amber box payments are limited and subject to reduction commitment, while blue and green box payments are exempt from reduction. In US farm assistance, disaster payments and payments under CRPs are classified into green boxes. Crop insurance programs are assigned to amber boxes as they reduce yield and price risks and these effects are known to farmers when they make their planting decisions. Regarding commodity programs, MLs and CCPs are categorized as amber box payments as these supports are related to market prices and/or current production. DP is related to neither market condition nor current production and is currently assigned to green box payments.

3. Data Description and Summary of Statistics

Data Description

This study uses data on farm exports[3] of 46 US states with the 100 biggest trading partners, which account for 98% of the US total trade of all merchandise (sum of imports and exports). Alaska, North Dakota, South Dakota, Wyoming, and the District of Columbia are excluded from the sample as their trade flows are negligible. These regions together make up less than 2% of total trade value. Annual data of bilateral export value for aggregate farm products as well as data on agricultural and livestock exports are collected from *International Trade Administration* (US Department of Commerce). Regarding export flows for major crops (cotton, corn, wheat, soybean, rice, oats, barley, and grain sorghum), data are extracted from the Harmonized System at the 6-digit level from *USA Trade Online*. While aggregate export flows are available from 1999 to 2011, the data on major crop exports are available from 2002 to 2011.

Data on domestic subsidies per annum for each state at both the aggregate and disaggregate level in the same time period as for exports are obtained from the Farm Subsidy Database of the *Environmental Working Group* (EWG).[4] Data on different subsidy programs used in this study include commodity, disaster, crop insurance, CRP, DP, and CCP. Meanwhile, subsidy data for specific commodities include those for cotton, corn, wheat, soybeans, rice, oats, barley, grain sorghum, and livestock.

Gross domestic product (GDP) and per capita gross domestic product (GDPC) at the state level are derived from the *US Department of Commerce* (Bureau of Economic Analysis). Bilateral distance between one state and its trading partner is the flight distance between the two corresponding capital cities calculated by the author using the website *Worldatlas*.

Regarding data for production regressions, the outcome for major crop production, including output, planted area, harvested area, and yield, is acquired from the *US Department of*

[3] Farm exports include agricultural exports, which encompass crop and dairy products, and livestock product exports.
[4] The EWG database can be accessed via the following link: farm.ewg.org

Agriculture. Data on weather covariates, the precipitation index, and the temperature index are collected from the *National Oceanic Atmospheric Administration*. Meanwhile, information on input, including capital, labor, chemicals, pesticides, and fertilizers used in agricultural production, is obtained from the *United States Department of Agricultural Economic Research Service*. All these input variables are measured in indices comparing input usage of a state in a particular year with that of Alabama in 1996. Finally, state-level data on population are obtained from the *Administration for Commodity Living.*

Descriptive Statistics

Subsidy payments differ substantially across states. Figure 1.1 illustrates the frequency of payments to states with varying levels of total subsidy receipt. The distributional graph shows that almost half of the states (23) receive less than $200 million annually. Meanwhile, 9 out of 46 states are granted from $200-$400 million. This figure continues to decrease when the level of payments increases, leaving only 3 states with more than a $1.3 billion subsidy received per year. Likewise, substantial variation in subsidy payments across states is depicted in Figure 1.2. In particular, each year Rhode Island received the modest amount of $1.33 million while Texas was awarded $1,757.08 million. In addition, New Hampshire, Hawaii, Nevada, Connecticut, and Massachusetts received approximately $39.71 million per annum, making up only the tiny proportion of 0.232% of the total subsidy granted. In contrast, only three states (Illinois, Iowa, and Texas) top the list and together make up the lion's share of 27.5% ($4,709.77 million/year). Furthermore, Figure 1.3 reflects the volatility in the mean of subsidy receipt by state and states' corresponding mean of export value over the same time period.[5] Figure 1.3 shows a co-movement in subsidy and export value by state. At the same time, Figure 1.4 through Figure 1.6 illustrate the same points as Figure 1.1 through Figure 1.3 for the group of major crops. Note that the most remarkable features of these figures are almost the same as those in Figure 1.1 through Figure 1.3. This is understandable as these crops are most important for both US subsidization policy and US exports. These commodities, hence, convey the most important characteristics of the subsidies and exports of the aggregate data.

[5] In this case, there is an adjustment about the unit of the two variables so that they fit in one figure. While export value (in dollars) is divided by 2*10^9, subsidy is rescaled by 10^8.

The within-state variation of subsidy receipts is also large. Several subsidy payments which are triggered upon market price or revenue such as CCP or AEAC make them largely different from year to year. Averaged over all states, subsidy payments in 2000 were more than twice those in 2011. In addition, this within-state variation is quite different between states. For example, Rhode Island received support of $2.6 million in 2005, which is 13 times higher than its support in 2011. Hawaii's receipt of support is also 6 times higher in 1999 than in 2009. By contrast, Texas consistently receives a large amount of support over time with the maximum value being only as twice larger than the minimum value over the sample period. For summary statistics of the main covariates used in this paper see Table 1.

4. Empirical Framework: The Gravity Model

Standard Gravity Model

The method used in this paper is the gravity equation. First introduced by Tinbergen (1962), the gravity equation has been the most important empirical model in explaining the volume (value) of bilateral trade. This model successfully explains the trade flow when it is applied to different trade datasets. The empirical success of the gravity model has also motivated trade theorists to set up theoretical models from which some form of the gravity equation is derived.

The theoretical foundation of the gravity model was first established by Anderson (1979). It was then expanded by Bergstrand (1989, 1990) and Deardorff (1998) through the addition of the monopolistic competition or Hecksher-Ohline structure to explain specialization. In addition, the gravity equation is consistent with both standard trade models based on perfect competition (Bergstrand, 1985; Deardorff, 1998) and new trade models based on imperfect competition and economies of scale (Helpman, Melitz, and Rubinstein, 2008).

The econometric specification used in this paper is as follows:

$$Ln(EX_{ijt}) = a_{jt} + \alpha_1 Ln(subsidy_{it}) + \alpha_2 Ln(GDP_{it}) + \alpha_3 landborder_{ij} + \alpha_4 coastline_i + \alpha_5 Ln(distance_{ij}) + \varepsilon_{ijt} \quad (1)$$

where EX_{ijt} is export value from state *i* to importer *j* in year *t*; $subsidy_{it}$ is the subsidy value granted for state *i* in year *t*; GDP_{it} is states' GDP; $landborder_{ij}$ is a dummy variable equal to 1 if state i and exporter j share a land border and 0 otherwise; and $coastline_i$ is a dummy variable equal to 1 for states having a coastline and 0 otherwise. *Distance* is the bilateral distance between the capital city of a state and its trading partner and represents the transaction cost. In the gravity regressions above, a_{jt} are included to control for importer-year-specific factors. This obviates the demand to use data on basic gravity model variables, especially data on the subsidy granted by importer countries whose quality and credibility are questionable due to a number of missing observations and inaccurate notifications (Nuetah et al., 2011). Furthermore, importer-year interaction dummies also account for "multilateral resistance" from the importer side. Failing to control for this price index will bias gravity coefficient estimates (Anderson and Vanwincoop, 2003).[6]

Endogeneity Problem and Fixed-Effect Gravity Model

The challenge in identifying the effect of subsidies on exports needs to be clarified and addressed. Of most concern in the identification strategy in this case is endogeneity in the subsidy policy. Assistance might target states that have more potential in the agricultural sector, such as having high cropland quality or a climate pattern favoring agricultural production. The first evidence for this argument is that most of subsidy programs are paid on planting acreage and yield. Importantly, the relative ranking of states in receiving subsidies changes little over time. For example, Illinois, Texas, and Iowa are among the top five largest recipients for every single year in the investigated time period (13 years). At the same time, Rhode Island, New Hampshire, and Hawaii are among the five that received the smallest amount of support in almost all years. This evidence suggests that endogeneity is more serious for cross-sectional variation than for within-state variation in subsidy payments. In other words, it is more likely that the support policy is aimed at specific states based on their exports or production achievements in general, but its direction would not be altered year by year. Other evidence that supports the above argument is that US farm bills are renewed every five years and few changes

[6] Anderson and van Wincoop (2003) point out that the bilateral trade between country i and country j depends not only on the two countries' characteristics such as their GDPs and the characteristics specific to the pair such as the bilateral distance between them, but also on the resistance between each country and the rest of the world. The larger the resistance between the two countries to the rest of the word, the more they trade with each other, keeping everything else constant. This resistance is called "multilateral resistance" or multilateral price index and is a nonlinear function of the right-hand side variables. Multilateral resistance therefore has a correlation with independent variables in the gravity model. This implies that omission of multilateral resistance in estimating the gravity model can result in biased gravity estimates. Anderson and van Wincoop (2003) and Feenstra (2004, Ch.5) show that price index can be estimated by country fixed effects for cross-sectional data and by country year interaction dummies in panel data.

have been observed over the farm bills, at least in the sample period. In the econometric view, the problem of endogeneity mentioned above is caused by omitted variables (and simultaneity). States with favorable conditions for farming practice would generally be more prosperous in agricultural production and export and receive more subsidies at the same time. These related-productivity factors (better soil typology and climate pattern, as said before) may be unobservable (to econometricians). If these unobservable factors are not accounted for in the standard gravity model, the coefficient of interest is likely to be biased upward. Therefore, we account for the endogeneity problem by adding state dummies (b_i) to specification (1). In addition the year indicator is also added to account for trade shock or production shock in a given year, which is common for the US as a whole. Moreover, region[7] year interaction indicators (c_{rt}) capture the impact of time-varying omitted variables common for states within the same region. These time-varying variables may convey information about transient shocks such as drought and pests that associate with production, export, and subsidies. They also grasp any spillovers of subsidy to neighboring states. Taken together, the enriched form of equation (1) is as follows:[8]

$$Ln(EX_{ijt}) = a_{jt} + b_i + c_{rt} + \alpha_1 Ln(subsidy_{it}) + \alpha_2 Ln(GDP_{it}) + \alpha_3 landborder_{ij} + \alpha_5 Ln(distance_{ij}) + \varepsilon_{ijt} \quad (2)$$

Regarding the impact of subsidy payments on production of the group of major crops, we use a similar framework with original and estimating equations, as below:

$$Ln(Y_{it}) = \phi Ln(subsidy_{it}) + \varphi X_{it} + \varepsilon_{it} \quad (1')$$

$$Ln(Y_{it}) = b_i + c_{rt} + d_i + \phi Ln(subsidy_{it}) + \varphi X_{it} + \varepsilon_{it} \quad (2')$$

where Y_{it} denotes outcome for production, including output, planted area, harvested area, and yield. X_{it} is a vector of explanatory variables measured in an index, namely, the weather index (precipitation and temperature index) and the input use index (capital, labor, chemicals, pesticides, and fertilizers). In addition, we add a crop-specific factor to take into account the differences between crops in the estimating equation. For the outcome for output and harvested area, we control for planted area in the model along with the variables defined in X_{it}.

[7] Region used in this study is Farm Resource Regions (FRR) constructed by United States Department of Agricultural (USDA). FRR classification bases on specification in agricultural production at county level. A state may contain counties which belong to different regions. In this situation we assign that state to a region which encompasses the largest number of counties. A Brief description of the characteristics of FRR by USDA is presented in Appendix Table 1 while assignment of states to an according region is reported in Appendix Table 2.

[8] Coastline is dropped out owing to perfect multi-collinearity with state dummies.

5. Results and Analysis

5.1 Impact of Subsidies on Exports

Overall Effect of Subsidies

As mentioned earlier, the endogeneity of the subsidy policy which targets states with higher agricultural production and export performance may overestimate the subsidy effect. To see how the potential endogeneity of subsidy policy (or equivalently the ignorance of state unobservables in this case) confounds the effect, we report estimates from pooled data in columns from (1) to (3) in Table 2. In column (1), importer year interaction dummies are represented for importer characteristics over time while only subsidy is included regarding the state side. The specification in column (2) includes year indicators and other basic gravity variables, namely, GDP, land border, coastline, and distance. Region-by-year dummies are subsequently included in the specification in column (3). As seen from columns (1) and (2), the effect of subsidies on exports from these two specifications is large at 0.52 and 0.65, respectively. When time-varying variables at the region level are included, the effect slightly decreases to 0.449. Specifically, once time-invariant differences among states are taken into account as in column (4), the estimate immediately drops by more than three times to 0.133. The estimate indicates that a one percentage point decrease in subsidization for agriculture would reduce US agricultural export by 0.13%. Equivalently, if US farm subsidization is abolished, its farm product export to the world market would decrease by 13.3% or $50.8 billion each year[9]. This means that other countries, especially poor countries that heavily depend on agriculture for their economic development, would have better opportunities in terms of world market access.

As demonstrated in the previous section, endogeneity in the subsidy policy likely stems from cross-section rather than within-state regressions. Regression results consistently reflect the endogeneity of cross-sectional estimates as their average magnitude (of estimate from column (1) to (3)) is more than four times larger than within-state estimates. Nonetheless, we check whether the endogeneity of the subsidy policy matters for within-state estimations. In this case, a reverse causal relationship exists if trade shock or trade performance provides feedback for future subsidy changes. The requirement of no "feedback effect" is referred to as a "strict exogeneity" condition for fixed-effect estimation to be consistent. As suggested by Wooldridge (2002, p. 285)

[9] This figure is a result of multiplication between US's annual export value at $382 billion dollar with 0.133.

and used by Baier and Bergstrand (2007), the future value of the variable of interest is added to the fixed-effect specification as a simple way to test for the "feedback effect." If the subsidy is strictly exogenous, then the future subsidy would not be related to concurrent trade value. As seen in Table 2, column (5), the coefficient of the subsidy at time t+1 is small and not different from zero. This implies that endogeneity in the form of "feedback effect" is not a problem for within-state estimation.

In addition to the coefficient of interest, estimates of other covariates are also sensible and in line with existing studies using the gravity model. The coefficient of distance, which is the proxy for transaction cost, is around -1.2. Meanwhile, sharing a land border increases trade by a factor of 1.4. The only variable whose impact on export is not the same as indicated by the gravity model theory is GDP. The estimated coefficient of this variable is negative and insignificant once the state fixed effect is controlled for. This would likely result from the multi-collinearity between GDP and subsidies, and especially between GDP and the state fixed effect. GDP changes slowly over time (Baier and Bergstrand, 2007) causing it to have a high correlation with time-invariant state characteristics. This is probably the case as the coefficient of GDP is negative only after state dummies are included. The high multi-collinearity, however, does not affect the estimate of the subsidy coefficient, as we show in the robustness check section.

Identifying the Effect through US Categorization of Subsidy Programs

The information on US categorization of subsidy payments into commodity, crop insurance, disaster, and conservation reserve programs provides another opportunity to further describe the impact of subsidy programs on exports. Commodity payments encompass programs that ensure a minimum market price such as CCP and loan deficiency payments or that provide a financing interim like a marketing loan gain. Accounting for almost two thirds of total subsidies and containing programs that are directly linked to market condition or current production, the impact of commodity payments is expected to be highly visible. On the contrary, CRP should not have a positive impact on exports as this program encourages farmers to allow erodible and infertile land to retire. Also, the disaster payment is intended to partly reduce financial losses caused by natural disasters and diseases. There is little doubt about the distortionary effect of this program on production and trade. Finally, crop insurance may have a certain impact on production and trade as it insures a minimum yield or output and is known to producers at the time of planting. Moral hazard, however, may exist as sometimes found in the insurance market, resulting in a reverse impact on production.

The impact of these programs on exports is reported in Table 3 Panel A. Similar to the regressions for overall subsidy, the effect of commodity, disaster payment, and crop insurance is large and positive in the first specifications and drops significantly once the state fixed effect is controlled for. The estimate of the CRP effect also drops in magnitude and becomes insignificant when time-invariant state differences are taken into account. The changes in estimates between specifications again confirm the likely association between the time-invariant factor of productivity and capability of production and trade. Failing to take this association into account would lead to misleading inferences.

The estimation in the last specification is as expected, confirming that the commodity program is the major contributor to export promotion. The effect is closed to the overall effect of subsidies at 0.094 and also statistically significant at the 5% level. The coefficient of disaster payments is positive while that of CRP is negative. Nonetheless, these estimates are both small and statistically insignificant. The crop insurance effect is negative and significant at the 1% level, suggesting that moral hazard may exist. When their crops are insured, farmers may have less incentive to prevent diseases or risk from occurring. In particular, they may use less risk-reducing input such as fertilizer and pesticides. In another aspect, less time or effort may be exerted in farming practices or management, which has been reported as occurring in the labor market. Nonetheless, the argument regarding moral hazard deserves future research and, in this paper, the evidence of moral hazard is suggestive rather than conclusive.

Identifying the Effect through WTO Categorization of Subsidy

In accordance with WTO rules and terminology, the US assigns price and/or current production-related programs, including CCP and ML, to the amber box. At the same time, support for disaster relief or payments divorced from market conditions or current production such as DP is categorized into the green box. Programs that encourage farmers to retire low land quality (CRP) are also classified into the green box. It is obvious that amber box payments would distort trade and production while green box payments would have minimal if any effect. The availability of detailed information on program payment categorization enables us to verify the effect of subsidies on US exports. In Table 3 Panel B, we report the estimated effect of subsidies for the amber box and green box on exports for the first four specifications as in Table 2. Subsidy payments belonging to the amber box represent a meaningful impact, indicating that a one percentage point decrease in these payments reduces US exports by 0.105%. The impact of the amber box subsidy is smaller than that of the overall subsidy. This is likely because the amber subsidy covers a narrower range of commodities than the overall subsidies. Meanwhile, the green box effect estimate is negligible and statistically insignificantly different from zero.

Subsidy effect of "decoupled" programs

To meet WTO disciplines, "decoupled" programs which break the link between support and current production were introduced. In the case of the US, "decoupled" payments include DP, which was signed into law in the FAIR Act of 1996 and CCP in the next farm bill (2002). Although DP and CCP are both paid on historical production, DP is predetermined while CCP hinges on market conditions. Although "decoupled" programs support farmers based on their crops' historical yield and base acreage, their "minimal" impact on production and trade stimulates considerable controversy. According to Hennessy (1998), under the condition of uncertainty, if producers are risk averse with decreasing absolute risk aversion (DARA) preferences, an increase in wealth would reduce absolute risk aversion. Also, government payments help to reduce income variability, referred to as the insurance effect. As a consequence of wealth and the insurance effect, "decoupled" payments might encourage farmers to grow in a crop area which is too risky otherwise. In addition, if farmers face credit constraints, direct payments can affect their investment plans by promoting liquidity easement (Goodwin and Mishra, 2005, 2006). Chau and de Gorter (2000) argue that direct payments can help cover fixed costs; thus, producers who would be forced to shut down otherwise can stay in business. Empirical studies on "decoupled" payments, though plenty, mainly focus on their production effect (Burfisher et al., 2000; Adams et al., 2001; Antón and Le Mouël, 2004; El-Osta et al., 2004; Makki et al., 2005; Goodwin and Mishra, 2005, 2006; Ahearn et al., 2006; Serra et al., 2005, 2011; Mcintosh, 2007; Key and Roberts, 2009; Bhaskar and Beghin, 2010; Femenia et al., 2010; O'Donoghue and Whitaker, 2010). To our best knowledge, no study sheds light on the effect of "decoupled" payments on trade. Rather, in studies that distinguish the impact of different subsidy programs on trade, "decoupled" payments are absent or their effect is assumed to be zero (Dewbre et al., 2001; Diao et al., 2001).

Assessing the impact of “decoupled” payments on US exports is also a main focus of this study. Table 4 presents the estimation results for the impact of DP and CCP on US exports using the most saturated specification as in column (4), Table 2. In the first column, only DP is included in the model along with basic gravity variables. Next, total subsidy (excluding DP) is added while the amber subsidy and green subsidy (both excluding DP) are presented in column (3). Columns (4)-(6) repeat the regressions in columns (1)-(3) with interaction between the log of DP and the log of GDP being added to see whether a wealth effect exists.[10] The effect of CCP is evaluated in the same way as for DP from columns (1)-(3) and results are shown in columns (7)-(9). Note that CCP is triggered by market condition, which is unknown to farmers at growing time. Expectations with regard to this program payment are thus important in farmers' production decisions. Following Goodwin and Mishra (2005, 2006), we use CCP in the previous year to represent expectations of CCP in the current year. The regression results indicate that DP has no significant impact on exports in all specifications. Meanwhile, the estimated impact of CCP is small compared to the overall subsidy (0.029 as opposed to 0.133) though consistently statistically significant at the 5% level in all regressions. The finding in this study is in line with those on the production effect of decoupled payments; that is, the impact of DP is negligible while that of CCP is more meaningful. Our results, therefore, support the current categorization of DP in the green box while CCP is clarified as an amber subsidy. In addition, the estimates of the amber box and green box effect are very similar to those in the previous section.

Impact of Subsidy on Export: Commodities vs. Livestock

To further examine the effect of subsidies on exports, we provide insight into the effect of subsidization for agricultural commodities (including all eligible crops and dairy) as one group and livestock as another. Almost all subsidy payments (more than 98%) go to the former group, leaving only a tiny proportion for the latter. In addition, support for the first group encompasses the major and most distorting program payments while livestock receives only disaster payments. The subsidy effect on exports, hence, is expected to be strong for the first group.

In a similar vein, we go further in this direction by evaluating the impact of subsidies on exports among major crops, including cotton, corn, wheat, soybean, rice, oats, barley, and

[10] On average, DP accounts for 27% of the total subsidy and 42% of the commodity payment while CCP makes up around one third of DP. Therefore, if a wealth effect exists, it should be more obvious in the case of DP. In addition, we do not have information to test whether credit constraint matters.

sorghum. These are the most important crops in terms of domestic production, subsidy receipt, and export. Meanwhile, farm and agricultural exports aggregate exports across all agricultural commodities, including those that do not receive a subsidy. The subsidy effect found for aggregate data, thus, may be lower than only for commodities which receive a subsidy. This may happen with a shift from other crops that do not receive or receive very little subsidy toward these major crops. Note, however, that in the aggregate data, the impact of subsidization on exports may include a spillover effect of subsidized commodities on other agricultural products. In particular, extra farm products induced by subsidies may encourage production of consumer-ready products because inputs can be provided at a lower price. If the positive spillover effect is strong, the subsidy effect can be larger for aggregate data than for the group of which all crops receive support. Thus, without detailed information, it is difficult to make inferences about the relative magnitude of the subsidy effect on exports between these two groups, one with aggregate data and the other containing all crops with the most significant payments. Nonetheless, the subsidy impact is expected to be more direct and visible among the group of crops that is a target of the subsidization policy.

Table 5 reports estimation results for agricultural exports in comparison with livestock exports as well as the export equation for the group of major crops. For all three equations, as space is limited, we report the results for the last specification. In addition, for the group of major crops, crop-specific indicators are also included to take into account the differences between individual crops.[11] The estimates indicate that the subsidy effect is driven by agricultural commodities while no effect is observed for livestock. More importantly, the subsidy effect among the group of major crops is 0.372-0.377, which is 3 times higher than that for the overall effect for aggregate data and strongly statistically significant at the 1% level. These results again strengthen identification of the subsidy effect on US exports.

Subsidy Effect on Exports of Different Farm Bills

As a general tendency, subsidization undertaken by developed countries has shifted toward programs that limit their distortion on production and trade to satisfy WTO regulations. The FAIR Act of 1996 significantly reformed the subsidization policy by divorcing the payment rate

[11] For the group of major crops, data on each individual crop are appended and kept separately instead of summing up across crops. This implementation for the export equation is to be consistent with the production equation. See the next section for a detailed explanation of the rationale for choosing this manner of implementation.

from current production and commodity prices. Ad hoc payments (MLA) in the following years and the subsequent Farm Bill 2002 legislated payments which again depended on market condition. The Farm Bill 2008 continued with few amendments from the previous farm bill, making the subsidization policy stable during this decade. To see how the subsidy impact changes over time, we allow the subsidy coefficient to vary over the farm bills. In this case, the effect of subsidy in a farm bill is identified by using within-state variation over the years in that farm bill. We do this for equations with outcome variables as in Table 2 and Table 5, including farm export, agricultural export, livestock export, and export of the group of major crops. The estimates for the last specification are reported in Table 8 from row (1) through row (4). The tendency is that the effect of the FSRI Act is largest while the effect of the FAIR Act of 1996 and Farm Bill 2008 is smaller and similar in magnitude. For example, the overall subsidy effect for the FSRI Act is 0.219 while for the FAIR Act of 1996 and Farm Bill 2008 the figures are 0.126 and 0.119, respectively. Likewise, for the group of major crops, the impact of the subsidy on exports under the FSRI Act is also larger than that of the Farm Bill 2008, as shown in row (4). Even for livestock, a positive impact has been found for Farm Bill 2002, though it is significant at only a weak level.

Robustness Check

In Bergstrand (1989) theoretical framework, GDP per capita (GDPC) represents a specialization in production (i.e., whether production is labor-intensive or capital-intensive). GDPC, on the other hand, may have a potential correlation with the subsidy level. This correlation may be negative if the US farm bills aim to support poor farmers, for example. Thus, to see whether estimates of the subsidy coefficients are driven by omitting this variable, we include it in the model. In addition, because GDP, GDPC, subsidy, and state dummies are also included in the model, it is likely that these variables have high multi-collinearity with each other. The clue regarding multi-collinearity is that GDP does not have the expected sign as indicated by theory (Anderson, 1979; Anderson and van Wincoop, 2003). We, therefore, drop both GDP and GDPC to see if estimates are sensitive to potential multi-collinearity. Another way to reduce multi-collinearity is to use the export share (export value rescaled by GDP) instead of the export level. This is equivalent to applying an assumption of unitary income elasticity, indicated by the theoretical work on the gravity model (Anderson, 1979; Anderson and van Wincoop, 2003). We mimic all regressions in the main analysis for these scenarios using the most saturated specification (as in column (4), Table 2). Results from Table 2, Tables 3, and Table 5 are presented in Appendix Table A3. Meanwhile, estimates for the impact of the subsidy effect on "decoupled" payments and the impact over years and farm bills are reported in Appendix Tables A4 and A5, respectively. Overall, the results confirm the estimated effect in the main analysis for all regressions in all scenarios. In short, an overall subsidy effect has been found at 0.12-0.15 and is statistically significant at the 5% level. The commodity program and program payments in the amber box are the cause of export promotion. The effect of non-distortionary programs such as CRP, disaster assistance, or those assigned to the green box is negligible. Meanwhile, DP does not affect exports, while the effect of CCP is moderate. Similar to the results in the main analysis, the export promotion effect is strong among major crops with a magnitude almost 3 times higher than the overall effect. In addition, the estimates are consistent over years and farm bills, with a slightly stronger effect being seen in the Farm Bill 2002.

Furthermore, although state heterogeneity and region by year indicators are taken into account in our model, time-variant omitted variables at state level might matter. In this case, export subsidy programs are most likely the important factors. This is because export subsidy programs are believed to significantly promote exports and are subject to reductions under the WTO agreement. On the other hand, export subsidies might be used as a means to push excessive production resulting from domestic subsidies to the world market[12] (Diao et al., 2001). If so, not controlling for this variable in the model would upwardly bias the coefficient of interest.

The most important export promotion programs undertaken by the US include export credit guarantees (ECGs) and direct export subsidies, including the Export Enhancement Program (EEP) and Dairy Export Incentive Program (DEIP). ECGs support US exports from the demand side by providing specific importing countries with credit guarantees at prevailing and competitive interest rates when they purchase a US agricultural commodity. Meanwhile, direct export subsidies (EEP and DEIP) offer exporters bonuses with some target destinations. EEP is

[12] This suspicion is especially relevant in our case when we find that the subsidy effect on exports has had a tendency to drop in recent years (from the Farm Bill 2008), but its impact on production does not move in the same direction. The reduction in the subsidy impact on exports, which is not rooted in the accordingly smaller impact on production, might be associated with the removal of export-promoting instruments in the same time period (from 2008).

mainly for wheat and wheat flour, while DEIP assists with the export of dairy products. It is likely that direct export promotion programs have a direct and clearer correlation with farm subsidies at the state level. Failing to control for these covariates because data are unavailable would bias the coefficient of interest. Fortunately, after the last significant use of EEP in 1995, it was rarely used with only negligible payments and repealed altogether in the Farm Bill 2008. In contrast, DEIP was in force until 2013 with relatively large payments in some years. Although the omission of DEIP might have a significant impact on the export of dairy products, the potential effect in the aggregate regression, if any, is expected to be small. This is because the DEIP payment is relatively small compared to an aggregate subsidy. Even in fiscal years 2009 and 2002 when the largest amount of DEIP was delivered, payments account for, respectively, 0.376% and 0.207% of the annual average aggregate payment. There are no DEIP payments from 2005 to 2008, and these figures are negligible in the remaining years of the investigated period. To see whether the omitted DEIP variable affects the estimate of subsidies on exports, we perform two regressions. In the first regression, we exclude dairy exports and the dairy subsidy in the aggregate data while dropping the years 2002 and 2009 (when DEIP is substantial) in the second regression. In these two cases, we use the last specification as in column (4), Table 2. The estimate of the subsidy impact on exports is even higher at around 0.16 for these two regressions and statistically significant at the 5% level. These results indicate that time-varying omitted variables are not a major issue, as anticipated.

As a final robustness check, we also include on the right-hand side of the gravity specification the TFP of US states. In theoretical trade models like Eaton and Kortum (2002), the country-specific productivity level is also a determinant of a country's exports. Farm subsidies may be allocated based on farmers' productivity, resulting in a positive correlation between subsidy support received by states and their productivity in general. Not allowing for the productivity level of U.S. states may result in omitted variable bias. The results show that, controlling for the state productivity level, the coefficient estimate of $Log(Subsidy_{it})$ is 0.135 and statistically significant at the 1% level.[13] Thus, the effect of subsidy payments on state exports remains essentially the same.

5.2 Impact of Subsidy on Production

[13] The detailed results are not presented to save space. They are however available upon request from the authors.

For the Agricultural and Related Output Index

To provide insight into the production effect of subsidies, we estimate the production equation with outcomes being the index of total farm output, livestock output, crop output, and related output.[14] For each of these four outcomes, we use three scenarios with different sets of inputs. The first set of inputs includes separate information on capital input (excluding land input), labor input, land input, chemicals, pesticides, and fertilizers. In the second and third scenarios, these inputs are incorporated into one index, total input and intermediate input, respectively. The weather covariates are the same as in the production regressions for the group of major crops (including precipitation and temperature index). Table 6 reports estimations using the last specification. The results show that the effect of subsidy on production is consistent with its effect on exports. To be more specific, subsidy has a positive and significant effect on the farm output index and crop output index, while the effect is positive though small and insignificant for livestock. Calculating at mean values a one percentage decrease in domestic subsidy leads to a 0.043% decline in total farm output.[15] In addition, the effect is slightly higher at 0.051% for crop output. The positive and significant impact is also seen for the related output index.

For the Group of Major Crops

We further investigate the impact of subsidy on production of the group of major crops (corn, wheat, cotton, rice, soybeans, grain sorghum, barley, and oats) for which domestic support is

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[14] Data on these outcome variables are available in the index, which is ratio of current output over output of Alabama in 1996. To be compatible with these data, we convert subsidy level into index in the same way. As all variables in the regression are measured in index, a linear equation is used instead of the log form. In addition, these output index data are only available before 2005, making the time dimension short if we use the sample from 1999 as in the production equation for the group of major crops. As indicated in Clark and Linzer (2012), fixed effect estimates encounter disadvantages when a panel has only a few years and a large number of individuals. Those disadvantages of fixed effect in such panel include inaccurate estimates with high variance and the loss of a large number of degree of freedom. In our situation, data from 1999 to 2004 will result in a panel with 6 years and 46 states, which is comparable to a showcase in Clark and Linzer (2012) where fixed effect estimates do not work well with a large biasness and are inaccurate. In reality, our regressions using these panel data illustrate the weakness of fixed effect estimates with large variance, especially in the last specification when a large number of dummies is used (region-by-year indicators along with state dummies). As a result, the estimates of subsidy effect are only statistically significant at a weak level, although sometimes they are positive in all regressions. To improve the performance of fixed effect estimates in this situation, we use the sample since subsidy data are available from 1995 onward, resulting in a panel with 10 years.

[15] A one unit decrease in the subsidy index would lead to a decrease of 0.019 units in the output index (estimates are averaged from the three scenarios). Converted to percentage at mean values, when total farm subsidy goes down by 29.3% (1/3.41), farm output would decline by 1.27% (0.019/1.5). Thus, a 1% drop in farm subsidy would result in a 0.043% (1.27/29.3) decrease in total farm output.

most remarkable.[16] Estimation with four outcomes, including output, harvested area, planted area, and yield, is carried out. In these estimates, data of each individual crop are appended and then crop-specific factors are added to account for differences in characteristics between crops.[17] Estimates of the last specifications for these four outcomes are reported in Table 7.[18] For corn, the original data for harvested area, output, and yield are available in two different categories, "corn for grain" and "corn for silage."[19] Therefore, for these outcomes, we run two separate estimations, one with "corn for grain" data and the other with "corn for silage" data and all data for other crops remain the same.

The results show that subsidy payments meaningfully encourage producers to harvest crops conditional on a given planted area. However, this effect is only seen in corn harvested for grain but not for silage purposes (columns (2) and (3), respectively). Meanwhile subsidies have a slightly negative impact with weak statistical significance on yield in both cases when "corn for grain" and "corn for silage" data are used. In contrast, the results represent strong evidence of expanding planted area for these crops at 0.78-0.79. As a result, crop output increases by 0.12% with respect to a 1% additional subsidization. Again, the impact of subsidy on output is only found for "corn for grain" but not for "corn for silage". The effect of subsidy on the group of major crops is more than doubled (2.44 times) of that found for crop output (all crop together) in the previous sub-section. This is understandable as the major crops are those that attract largest and most important subsidy payments.

Subsidy Effect on Production of Different Farm Bills

[16] Data for crop production (output, harvested area, planted area, and yield) are available for each crop. Collecting information for all crops, however, is time consuming. Furthermore, these eight crops are the most important ones for subsidization policy. For example, the first five crops account for 90% of the commodity payment, which encompasses the most trade-distorting programs. Thus, evaluating the production effect of subsidy for this group will yield useful implications.

[17] We do not sum data across different crops for the following reasons. First, there are plenty of missing values for each of these 8 crops. If we sum them and leave the missing data as undefined, there will be a large number of observations omitted in the final data. If we treat missing data as zero in the totaling process, it will not be accurate as zero and missing observations convey different information. Second, output and yield of some crops are measured in different units due to their characteristics. This makes the data unready for totaling. Converting data into the same unit would result in inaccuracy, however. For example, cotton output and yield are measured in bales and would be not compatible if they are converted into kilograms and summed with "corn for grain" or "corn for silage."

[18] Data are available from 2002 to 2011 for weather variables and from 1999 to 2004 for input use variables. Therefore, to prevent reducing the sample size, we create dummies equal to unity for missing observations for these variables. However, we also estimate the production equation without using missing dummies. The estimates are largely similar. The results are not reported due to space limitations but can be provided upon request.

[19] Corn output and yield are measured in bushels for the former category as opposed to tons for the latter. We do not sum "corn for grain" and "corn for silage" to get one measure of data for corn output and yield for the same reason as in footnote 15.

From Table 8 columns (5) through (16), it is obvious that the subsidy effect on the output index is considerably stronger for Farm Bill 2002 than Farm Bill 1996.[20] For total output index and crop output index, the effect of Farm Bill 2002 is more than twice as large as that of Farm Bill 1996. For the related output index, this figure is 1.4 times larger. Even for the livestock output index where the overall livestock subsidy effect (columns (7) through (9) in Table 6) is found to be negligible and insignificant, the effect for Farm Bill 2002 is positive and significant (though small) in two out of three specifications. The tendency that Farm Bill 2002 generates a larger effect on production than Farm Bill 1996 is in agreement with that for exports.

For the group of major crops, the difference in effect of Farm Bill 1996 and Farm Bill 2002 is similar though not very strong. As in row (20), the effect for output ("corn for grain") is 0.108 and 0.119 for Farm Bill 1996 and Farm Bill 2002, respectively. Regarding the effect of Farm Bill 2002 and Farm Bill 2008 on output (again "corn for grain" where the subsidy effect is positive), the effect is slightly higher for Farm Bill 2008 than Farm Bill 2002. This difference contradicts the relationship in the export estimate for farm output, agricultural output, and major crop output (in rows (1), (2), and (4) of Table 8). This implies that the weaker effect of subsidy on export for Farm Bill 2008 does not stem from associated smaller production. One possibility is that in recent years the US has withdrawn the use of export policies that supplement domestic support to push excessive production to the world market. Removal of the ECG and EEP after 2008 is an example. Alternatively, the federal government may support domestic commodity consumption from the demand side or raise stock accumulation.

6 Conclusion

In the ongoing Doha Development Agenda, domestic subsidies undertaken by industrialized countries have captured huge attention from WTO members. The US has a long history of intensively using subsidies to support its producers. More important, there is no consistent tendency to reduce or withdraw production support over time. Thus, assessment of US subsidization on trade is crucial. This study responds to such an important call by utilizing a

[20]Recall that for outcomes of total output index, related output index, livestock output index, and crop output index, data are available from 1995 to 2004. We thus can only assess the impact of subsidy for Farm Bill 1996 (using 1996 to 2001) and Farm Bill 2002 (using 2002 to 2004).

unique longitudinal dataset of US subsidies at the state level. Geography and time variation in the subsidy are utilized to fit in the modern gravity equation. In particular, potential endogeneity induced by the nature of the subsidy policy is taken into account by exhausting panel data at the state level.

Our results indicate a positive and meaningful impact of domestic subsidies on exports. Abolishing domestic support would result in a 13%-14% decrease in US exports. This result is confirmed when regression testing for no "feedback effect" is performed. The decline of 13%-14% in exports equates to a value of $50-$53 billion annually. Importantly, the effect is determined by programs that relate to current production decisions or interfere with market conditions. Those are assigned to amber box payments under WTO disciplines or commodity payments according to the US classification. Equivalently, with a different division, the subsidy effect is driven by agricultural commodities, which are the main targets of distorting program payments. In addition, CRP and disaster payments offer a great opportunity to conduct a falsification exercise. CRP encourages farmers to retire low-quality land while disaster payments offer ex post support. Therefore, the effect of these program payments on production and trade is negligible, if any. The estimates of these two program impacts are small at -0.049 and 0.022 and both are statistically insignificant, verifying the analysis. In accordance with these results, the estimated impact of green box payments, which basically lump these two programs together, is even smaller due to an offsetting effect as CRP and disaster payments affect production and trade in the opposite direction. Meanwhile, DP does not promote exports, while CCP has a positive impact though the size is moderate. In addition, the subsidy effect among the group of most important subsidized crops is substantially larger at 0.37. Furthermore, the primary economic channel of the trade effect is uncovered. Completely in accordance with the impact on trade, the subsidy effect is positive and meaningful for total farm output and crop output while it is small and insignificant for livestock output. For the group of major crops, subsidies have substantially stimulated production area, resulting in a large increase in output. The production effect of subsidies for the group of major crops is more than doubled in magnitude compared with that for aggregate data and all crops. This is not surprising as these major crops are most subsidy-oriented.

In addition to the overall effect, the tendency of the subsidy impact over time is important from a policy perspective, especially when reform in the US subsidization policy has been waiting for. The effect of subsidies on exports, hence, is allowed to vary over farm bills. The estimates indicate that a “production flexibility contract” which allows farmers to freely choose crops based on market signals and still be eligible for support has the least distorting effect on production and trade of the three farm bills. In addition, the effect of subsidy on exports tends to decrease in Farm Bill 2008 compared to Farm Bill 2002. This tendency, however, has not been identical for the production effect in the group of major crops. To be more specific, the production effect of subsidy in the Farm Bill 2008 is slightly higher than for the FRSI Act. This implies that the reduced export distortion in the Farm Bill 2008 does not come from an according reduction in production but from other instruments; removal of direct export subsidies, encouragement of domestic demand, and raising capital stock are some possibilities.

We perform a series of robustness checks. These include regressions with GDPC being added and regressions without GDP and GDPC. Regressions are mimicked with outcome being export share instead of export level. In addition, potential time-varying omitted variables, export subsidies, are also taken into account. The results are robust throughout all these regressions, confirming the effect of US subsidization in the main analysis.

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Figure 1: Frequency of States with Varying Value of Subsidy

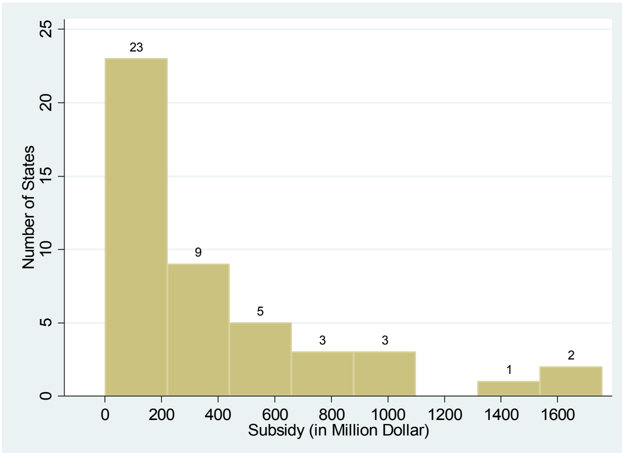

Figure 2: Mean of Total Subsidy Receipt for States

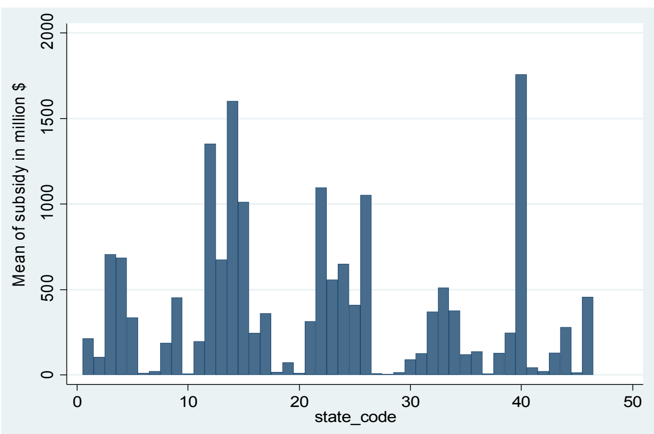

Figure 3: Movement of Farm Export and Farm Subsidy

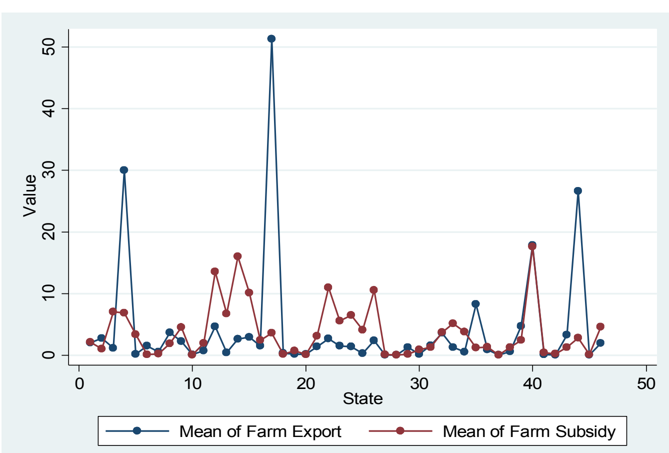

Figure 4: Frequency of States with Varying Value of Subsidy (Major Crops)

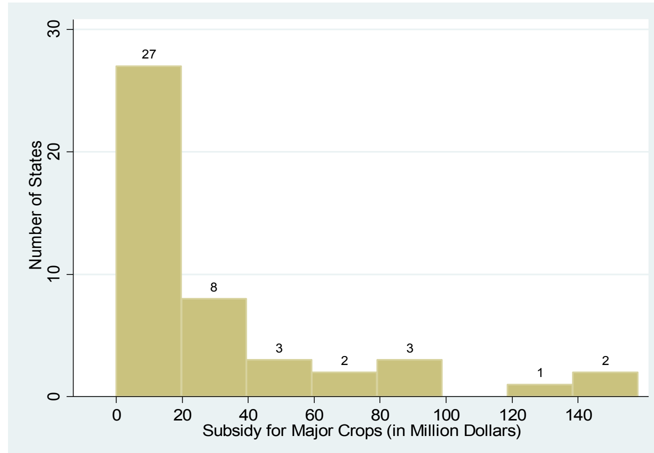

Figure 5: Mean of Total Subsidy Receipt for States (Major Crops)

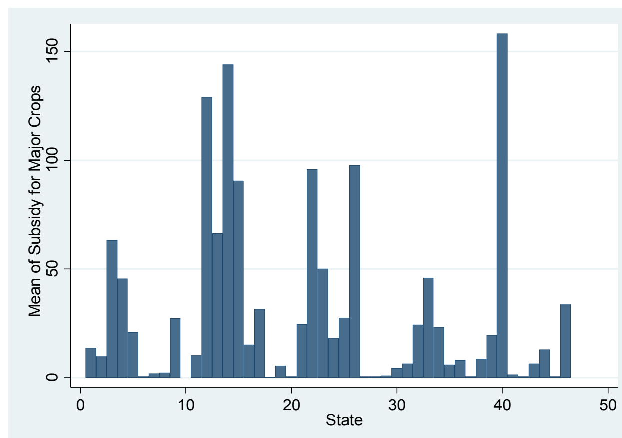

Figure 6: Movement of Export and Subsidy (Major Crops)

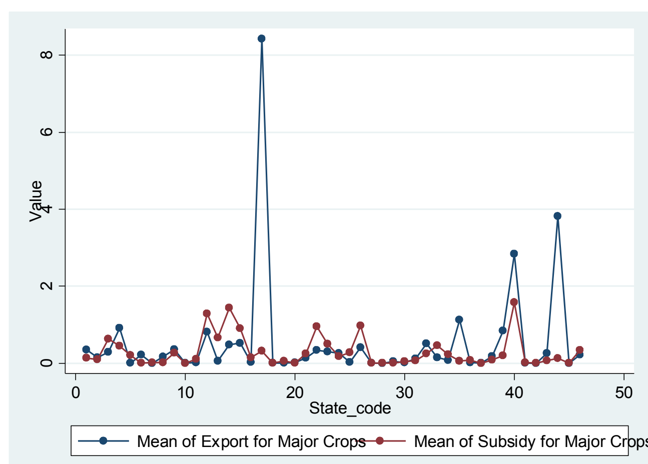

Table 1: Summary Statistics

Variables	mean/sd	observations	Variables	mean/sd	Observations
Farm Export Value ($ Billion)	8303 (78290)	59800	Crop Subsidy Index	3.505 (4.741)	454
Bilateral Distance	5399.6 (2180.2)	59800	Total Output Index	1.501 (1.532)	450
Land Border	0.00326 (0.0570)	59800	Related Output Index	1.157 (1.461)	450
Coastline	0.48 (0.5)	59800	Livestock Output Index	0.928 (0.835)	450
GDP	261462.4 (294947.4)	59800	Crop Output Index	3.065 (3.696)	450
Subsidy Value ($ Million)	372.744 (471.544)	59800	Intermediate Input Index	1.073 (0.989)	450
Commodity Program	238.066 (361.277)	59800	Total Input Index	-216.1 (1460.1)	460
Conservation Reserve Program	45.436 (52.713)	59800	Capital Input	1.533 (1.296)	2340
Disaster Payment	30.114 (58.104)	59800	Labour Input	1.886 (1.747)	2340
Crop Insurance Payment	59.104 (88.627)	59800	Chemical	2.233 (2.395)	2340
Amber Box	198.259 (296.479)	59800	Pesticide	1.972 (2.072)	2340
Green Box Including DP	174.461 (204.811)	59800	Fertilizer	2.458 (2.801)	2340
DP	97.526 (124.058)	59800	Precipitation Index	37.84 (13.97)	450
CCP	31.6 (72.9)	46000	Temperature Index	627.7 (69.82)	450
Subsidy without DP	273.834 (359.990)	59800	Planted area for major crops	672.29 (1799.78)	4237
Subsidy for Major Crops	259.883 (392.152)	59800	Harvested Area for Major Crops	657.60 (1762.44)	4030
Subsidy Index	3.406 (4.540)	460	Output for Major Crops	49324.65 (199274.5)	4148
Livestock Subsidy Index	1.110 (2.775)	454	Major Crop Yield	338.35 (1160.5)	2549

Table 2: Overall Effect of Subsidy on Farm Export

	(1)	(2)	(3)	(4)	(5)
ln Subsidy	0.516***	0.651***	0.588***	0.133**	0.142**
	(22.94)	(25.19)	(19.48)	(2.25)	(2.25)
ln Distance		-0.420***	-0.848***	-1.218***	-1.186***
		(3.25)	(6.72)	(10.13)	(10.08)
Ln GDP		0.327***	0.477***	-0.415	-0.506
		(7.53)	(9.86)	(0.96)	(1.07)
Land Border		1.795***	1.546***	1.395***	1.431***
		(5.29)	(4.99)	(3.97)	(4.05)
Coastline		1.513***	0.905***		
		(17.22)	(7.58)		
ln Subsidy at time t+1					0.0212
					(0.36)
N	29522	29522	29165	29165	26764
adj. R^2	0.279	0.389	0.444	0.498	0.496

Notes: Robust standard errors are exporter-importer clustered. *t*-statistics are in parentheses. *, **, or *** indicates significance at the 10%, 5%, or 1% levels, respectively.

Table 3: Impact of Different Subsidy Programs on Farm Export

	(1)	(2)	(3)	(4)
Panel A: US's Categorization				
Ln Commodity	0.434***	0.375***	0.288***	0.0939**
	(9.88)	(8.38)	(5.65)	(2.02)
Ln Disaster Payment	0.241***	0.169***	0.0494	0.0218
	(12.21)	(6.05)	(1.46)	(1.59)
Ln Conservation Reserve Program	-0.446***	-0.152***	0.0597	-0.0486
	(9.57)	(2.69)	(1.06)	(1.31)
Ln Crop Insurance	0.195***	-0.0244	0.0267	-0.180***
	(4.00)	(0.45)	(0.49)	(2.59)
Ln Distance		-0.353**	-0.894***	-1.219***
		(2.48)	(6.95)	(10.16)
Ln GDP		0.600***	0.694***	-0.438
		(8.74)	(12.74)	(1.01)
Land Border		1.649***	1.473***	1.395***
		(4.90)	(4.55)	(3.95)
N	29422	29422	29065	29065
adj. R^2	0.308	0.340	0.435	0.498
Panel B: WTO's Categorization				
Ln Subsidy Amber	0.561***	0.596***	0.249***	0.105*
	(14.48)	(15.78)	(6.66)	(1.83)
Ln Subsidy Green	-0.149***	-0.0220	0.211***	0.0130
	(2.92)	(0.49)	(4.50)	(0.41)
Ln Distance		-0.341***	-0.859***	-1.218***
		(2.60)	(6.72)	(10.13)
Ln GDP		0.292***	0.706***	-0.351
		(6.51)	(17.45)	(0.81)
Land Border		1.822***	1.525***	1.393***
		(5.50)	(4.86)	(3.96)
N	29522	29522	29165	29165
adj. R2	0.285	0.391	0.435	0.498
Importer by Year Dummies	Yes	Yes	Yes	Yes
Year Dummies	No	Yes	Yes	Yes
Region by Year Dummies	No	No	Yes	Yes
State Dummies	No	No	No	Yes

Notes: Robust standard errors are exporter-importer clustered. *t*-statistics are in parentheses. *, **, or *** indicates significance at the 10%, 5%, or 1% levels, respectively.

Table 4: Subsidy Impact of DP and CCP on Farm Export

	(1) lfarm_ex	(2) lfarm_ex	(3) lfarm_ex	(4) lfarm_ex	(5) lfarm_ex	(6) lfarm_ex	(7) lfarm_ex	(8) lfarm_ex	(9) lfarm_ex
Ln DP	-0.149	-0.132	-0.135	0.643	0.645	0.720			
	(1.24)	(1.10)	(1.12)	(0.93)	(0.93)	(1.03)			
Ln Distance	-1.222***	-1.222***	-1.222***	-1.222***	-1.223***	-1.222***	-1.923***	-1.923***	-1.923***
	(10.13)	(10.13)	(10.13)	(10.13)	(10.13)	(10.13)	(7.18)	(7.18)	(7.18)
Ln GDP	-0.335	-0.402	-0.357	0.862	0.774	0.933	0.631	0.476	0.654
	(0.77)	(0.92)	(0.82)	(0.76)	(0.68)	(0.82)	(0.76)	(0.56)	(0.76)
Land border	1.397***	1.397***	1.395***	1.396***	1.396***	1.395***	0.903**	0.904**	0.903**
	(3.97)	(3.97)	(3.96)	(3.97)	(3.97)	(3.96)	(2.31)	(2.31)	(2.30)
Ln Subsidy		0.0976**			0.0971**				
(Excluding DP)		(2.06)			(2.05)				
Ln Subsidy Amber			0.0587			0.0614*			
			(1.58)			(1.65)			
Ln Subsidy Green			0.00832			0.00809			
(Excluding DP)			(0.26)			(0.25)			
Ln DP*Ln GDP				-0.0664	-0.0652	-0.0716			
				(1.16)	(1.14)	(1.24)			
Lag ln CCP							0.0287**	0.0295**	0.0301**
							(2.42)	(2.48)	(2.50)
Ln Subsidy								0.173	
(Excluding CCP)								(1.54)	
Ln Subsidy Green									0.0300
									(0.36)
Ln Subsidy Amber									0.0704
(Excluding CCP)									(1.11)
N	29121	29121	29121	29121	29121	29121	15220	15220	15220
adj. R^2	0.498	0.498	0.498	0.498	0.498	0.498	0.529	0.529	0.529

Notes: Robust standard errors are exporter-importer clustered. *t*-statistics are in parentheses. *, **, or *** indicates significance at the 10%, 5%, or 1% levels, respectively.

Table 5: Impact of Subsidy on Export, Crops v.s Livestock

	(1)	(2)	(3)
Outcome Variables →	Ln Agricultural Export	Ln Livestock Export	Ln Major Crop Export
Ln Subsidy	0.108*	-0.0148	0.369***
	(1.70)	(1.24)	(8.74)
Ln Distance	-1.204***	-0.907***	-1.513***
	(9.61)	(6.36)	(6.32)
Ln GDP	0.112	-2.807***	0.300
	(0.24)	(3.89)	(0.43)
Land Border	1.301***	2.237***	0.959**
	(3.49)	(6.70)	(2.54)
N	26186	11236	19033
adj. R^2	0.502	0.352	0.383
Importer by Year Dummies	Yes	Yes	Yes
Year Dummies	Yes	Yes	Yes
State Dummies	Yes	Yes	Yes
Region by Year Dummies	Yes	Yes	Yes
Crop Specific Indicators	NA	NA	Yes

Notes: Robust standard errors are exporter-importer clustered. *t*-statistics are in parentheses. *, **, or *** indicates significance at the 10%, 5%, or 1% levels, respectively.

Table 6: Impact of Subsidy on Agricultural and Related Output Index

Outcome Variables →	(1) Total Output Index	(2) Total Output Index	(3) Total Output Index	(4) Related Output Index	(5) Related Output Index	(6) Related Output Index	(7) Livestock Output Index	(8) Livestock Output Index	(9) Livestock Output Index	(10) Crop Output Index	(11) Crop Output Index	(12) Crop Output Index
Subsidy Index	0.0219***	0.0203***	0.0146***	0.0427***	0.0302**	0.0284*	0.00214	0.00334	0.00286	0.0479***	0.0468***	0.0380**
	(4.50)	(3.73)	(3.17)	(3.89)	(2.25)	(1.82)	(1.45)	(1.30)	(1.31)	(3.00)	(3.45)	(2.67)
Capital Input Index	0.286			0.535			0.113			0.589		
	(0.99)			(1.15)			(0.75)			(0.62)		
Labour Input Index	-0.0220			0.365			-0.0479**			-0.0847		
	(1.01)			(1.39)			(2.31)			(0.98)		
Land Input Index	-0.0965			-0.334			-0.0417			-0.268		
	(0.53)			(1.18)			(0.35)			(0.49)		
Chemical Input Index	-1.055***			-0.529			-0.592***			-2.209**		
	(4.42)			(1.40)			(3.65)			(2.10)		
Pesticide Input Index	0.462***			0.209			0.241**			0.991*		
	(3.92)			(1.25)			(2.53)			(1.97)		
Fertilizer Input Index	0.600***			0.369**			0.330***			1.262**		
	(4.35)			(2.30)			(4.48)			(2.20)		
Precipitation Index	-0.000673	-0.00266	-0.00171	0.00298	-0.00123	0.00309	-0.000777	-0.00204	-0.00157	-0.00138	-0.00497	-0.00396
	(0.67)	(1.21)	(0.80)	(1.26)	(0.41)	(1.15)	(0.92)	(1.48)	(1.30)	(0.46)	(0.94)	(0.72)
Temperature Index	0.0000126	-0.000120	-0.0000997	-0.000651	-0.000432	-0.000221	0.000124	-0.00000637	-0.0000248	-0.0000605	-0.000225	-0.000216
	(0.10)	(0.34)	(0.30)	(1.50)	(1.04)	(0.55)	(1.30)	(0.03)	(0.13)	(0.14)	(0.27)	(0.27)
Total Input		0.459**			1.874**			0.263***			0.478	
		(2.10)			(2.56)			(2.87)			(0.86)	
Intermediate Input Index			0.641***			1.238*			0.440***			0.879
			(2.70)			(1.99)			(4.32)			(1.34)
N	450	450	450	450	450	450	444	444	444	444	444	444
adj. R^2	0.996	0.995	0.995	0.973	0.975	0.972	0.996	0.994	0.996	0.993	0.992	0.992
Year Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
State Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Region by Year Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Crop Specific Indicators	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: Robust standard errors clustered at state level. *t*-statistics are in parentheses. *, **, or *** indicates significance at the 10%, 5%, or 1% levels, respectively.

Table 7: Impact of Subsidy on Production for Major Crops

Outcome Variables →	(1) Ln Planted Area	(2) Ln Harvested Area (corn for grain)	(3) Ln Harvested Area (corn for silage)	(4) Ln Output (corn for grain)	(5) Ln Output (corn for silage)	(6) Ln Yield (corn for grain)	(7) Ln Yield (corn for silage)
Ln Major Crop Subsidy	0.791***	0.100***	-0.0565	0.123**	-0.0157	-0.0283*	-0.0321*
	(17.91)	(2.86)	(0.58)	(2.53)	(0.16)	(1.74)	(1.89)
Ln Major Crop Planted Area		0.963***	0.864***	0.897***	0.768***		
		(25.90)	(9.37)	(16.11)	(7.67)		
Capital Input Index	-0.0229	0.0120	0.00411	-0.00664	-0.0301	-0.0190	-0.0328*
	(0.63)	(1.43)	(0.33)	(0.32)	(1.64)	(0.94)	(1.93)
Labour Input Index	0.0202	-0.0000162	-0.0147*	0.0107	0.000845	0.00943	0.0134*
	(0.93)	(0.00)	(1.74)	(1.18)	(0.11)	(1.31)	(1.72)
Chemical Input Index	0.0234	-0.00991	-0.0153	0.00185	-0.00144	0.0123	0.0128
	(0.74)	(0.67)	(0.81)	(0.08)	(0.05)	(0.81)	(0.83)
Pesticide Input Index	-0.0324	0.00756	0.0327	-0.00219	0.0228	-0.00946	-0.00795
	(1.01)	(0.50)	(1.51)	(0.10)	(0.93)	(0.67)	(0.54)
Fertilizer Input Index	0	0	0	0	0	0	0
	(.)	(.)	(.)	(.)	(.)	(.)	(.)
Precipitation Index	0.0000418	0.00212***	0.000242	0.00227	0.000146	-0.0000557	-0.000204
	(0.02)	(2.87)	(0.32)	(1.66)	(0.13)	(0.06)	(0.23)
Temperature Index	0.000304	-0.000431**	-0.0000993	-0.000626**	-0.000134	-0.000184	-0.0000821
	(0.70)	(2.28)	(0.61)	(2.20)	(0.47)	(0.75)	(0.37)
N	2099	2009	2099	2003	2093	2010	2100
adj. R^2	0.940	0.987	0.901	0.979	0.903	0.975	0.978
Year Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes
State Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Region by Year Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Crop Specific Indicators	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: Robust standard errors clustered at state level. *t*-statistics are in parentheses. *, **, or *** indicates significance at the 10%, 5%, or 1% levels, respectively. Fertilizer Index is dropped in a number of regressions because of multi-collinearity.

Table 8: Impact of Subsidy on Export and Production over Different Farm Bills

	Outcome Variables ↓	Farm bill 1996	Farm bill 2002	Farm bill 2008
(1)	Ln Farm Export	0.126**	0.219***	0.119*
		(2.05)	(3.49)	(1.91)
(2)	Ln Agricultural Export	0.136**	0.200***	0.113*
		(2.05)	(3.03)	(1.70)
(3)	Ln Livestock Export	-0.0853***	0.0216*	-0.0157
		(3.55)	(1.65)	(0.54)
(4)	Ln Major Crop Export	NA	0.371***	0.365***
			(8.74)	(7.69)
(5)	Total Output Index	0.0227***	0.0303***	NA
		(3.95)	(3.03)	
(6)	Total Output Index	0.0190***	0.0495***	NA
		(4.03)	(3.06)	
(7)	Total Output Index	0.0150***	0.0409***	NA
		(5.37)	(3.49)	
(8)	Related Output Index	0.0408***	0.0418**	NA
		(4.24)	(2.38)	
(9)	Related Output Index	0.0272**	0.0506**	NA
		(2.45)	(2.29)	
(10)	Related Output Index	0.0245*	0.0327	NA
		(1.83)	(1.22)	
(11)	Livestock Output Index	0.00216	0.00136	NA
		(0.75)	(0.50)	
(12)	Livestock Output Index	-0.000798	0.00675**	NA
		(0.43)	(2.02)	
(13)	Livestock Output Index	0.000259	0.00539*	NA
		(0.15)	(1.80)	
(14)	Crop Output Index	0.0567***	0.102***	NA
		(3.58)	(3.72)	
(15)	Crop Output Index	0.0507***	0.132***	NA
		(4.24)	(3.64)	
(16)	Crop Output Index	0.0464***	0.122***	NA
		(4.90)	(4.26)	
(17)	Ln Planted Area	0.834***	0.782***	0.782***
		(17.15)	(18.36)	(16.31)
(18)	Ln Harvested Area (corn for grain)	0.0961**	0.0983***	0.109***
		(2.67)	(2.85)	(3.00)
(19)	Ln Harvested Area (corn for silage)	-0.0532	-0.0516	-0.0699
		(0.53)	(0.54)	(0.70)
(20)	Ln Output (corn for grain)	0.108**	0.119**	0.144***
		(2.07)	(2.50)	(2.90)
(21)	Ln Output (corn for silage)	-0.0205	-0.0155	-0.0152
		(0.20)	(0.16)	(0.15)
(22)	Ln Yield (corn for grain)	-0.0426**	-0.0279*	-0.0177
		(2.41)	(1.81)	(0.96)
(23)	Ln Yield (corn for silage)	-0.0440**	-0.0343**	-0.0175
		(2.33)	(2.08)	(0.96)

Notes: Robust standard errors clustered at state level. *t*-statistics are in parentheses. *, **, or *** indicates significance at the 10%, 5%, or 1% levels, respectively.

Appendix Table A1:

FRR codes	FRR Names	Main Features
1	Heartland	- Most farms (22%) - Highest production value (23%), largest cropland area - Cash grain and cattle farms
2	Northern Crescent	- Most populous region - 15% of farms, 15% of production, 9% of cropland - Dairy, general crop, and cash grain farms
3	Northern Great Plain	- Largest farms and smallest population - 5% of farms, 6% of production value, 17% of cropland - Wheat, cattle, and sheep farms
4	Prairie Gateway	- Second largest in wheat, oats, barley, rice and cotton production - 13% of farms, 12% of production, 17% of cropland - Cattle, wheat, sorghum, rice and cotton farms
5	Eastern Upland	- Largest share of small farms - 15% of farms, 5% of production value, 6% of cropland - Part-time cattle, tobacco, and poultry farms
6	Southern Seaboard	- Both small and larger farms - 11% of farms, 9% of production value, 6% of cropland - Part-time cattle, general field crops, and poultry farms
7	Fruitful Rim	- Highest proportion of large and very large farms - 10% of farms, 22% of production value, 8% of cropland - Farms growing fruit, vegetable, nursery and cotton.
8	Basin and Range	- 4% of farms, 4% of production value, 4% of cropland - Cattle, wheat and sorghum farms
9	Mississippi Portal	- Highest proportion of both small and larger farms - 5% of farms, 4% of production value, 5% of cropland - Cotton, rice, poultry, and hog farms

Source: USDA/Economic Research Service/ Agricultural Information Bulletin Number 760

Appendix A2: According regions of 45 U.S. states

FRR	State
1	Indiana, Iowa, Ohio, Illinois, Missouri
2	New Hampshire, Connecticut, Wisconsin, Maine, Minnesota, New Jersey, New York, Massachusetts, Rhode Island, Michigan, Vermont, Pennsylvania
4	Oklahoma, Texas, New Mexico, Kansas, Nebraska
5	West Virginia, Arkansas, Tennessee, Kentucky
6	South Carolina, North Carolina, Maryland, Georgia, Alabama, Virginia, Delaware
7	Oregon, Idaho, Florida, California, Arizona, Washington
8	Colorado, Nevada, Montana, Utah
9	Mississippi, Louisiana

Appendix Table A3: Impact of Subsidy on Export (Overall Subsidy and Subsidy by Categories)

Outcome Variables ↓	Variables ↓	(1) Estimates	(2) Estimates
	Ln Total Subsidy	0.148**	0.126**
		(2.48)	(2.16)
	Ln Commodity	0.117**	0.0899*
		(2.52)	(1.96)
	Ln Disaster	0.0238*	0.0213
		(1.73)	(1.56)
	Ln Conservation Reserve Program	-0.0576	-0.0509
		(1.54)	(1.37)
Ln Farm Export	Ln Crop Insurance	-0.199***	-0.179**
		(2.87)	(2.57)
	Ln Subsidy Amber	0.126**	0.105*
		(2.19)	(1.83)
	Ln Subsidy Green	0.0385	0.0260
		(0.80)	(0.55)
	Ln Subsidy for Agricultural Product Export	0.125**	0.110*
Ln Agricultural Export		(1.97)	(1.77)
	Ln Subsidy for Livestock Export	-0.0146	-0.0178
Ln Livestock Export		(1.23)	(1.49)
	Ln Subsidy for Major Crop Export	0.369***	0.369***
Ln Export of Major Crops		(8.73)	(8.74)
	Ln Total Subsidy		0.108*
			(1.86)
	Ln Commodity		0.0808*
			(1.76)
	Ln Disaster		0.0202
			(1.47)
	Ln Conservation Reserve Program		-0.0564
			(1.51)
Ln (Farm Export/GDP)	Ln Crop Insurance		-0.176**
			(2.53)
	Ln Subsidy Amber		0.104*
			(1.82)
	Ln Subsidy Green		0.00769
			(0.16)
	LnGDP	Yes	No
	LnGDPC	Yes	No

Notes: Robust standard errors are exporter-importer clustered. *t*-statistics are in parentheses. *, **, or *** indicates significance at the 10%, 5%, or 1% levels, respectively.

Appendix Table A4: Impact of Subsidies on "Decoupled" Programs

Outcome Variables ↓		(1) Ln DP	(2) Ln subsidy without DP	(3) Ln Subsidy Amber	(4) Ln Subsidy Green (Without DP)	(5) Ln DP* Ln GDP	(6) Ln CCP	(7) Ln Subsidy without CCP	(8) Ln Subsidy Amber (Without CCP)	(9) Ln Subsidy Green
Ln Farm Export										
	With GDP&GDPC	-0.0748					0.0397***			
		(0.61)					(3.23)			
	Without GDP&GDPC	-0.145					0.0297**			
		(1.21)					(2.48)			
	With GDP&GDPC	-0.0556	0.102**				0.0401***	0.160*		
		(0.46)	(2.14)				(3.27)	(1.68)		
	Without GDP&GDPC	-0.128	0.0930**				0.0297**	0.129		
		(1.07)	(1.99)				(2.49)	(1.36)		
	With GDP&GDPC	-0.0605		0.0681*	-0.00125		0.0412***		0.106**	-0.0566
		(0.49)		(1.84)	(0.04)		(3.35)		(1.99)	(0.80)
	Without GDP&GDPC	-0.133		0.0607*	0.00464		0.0314***		0.101*	-0.0792
		(1.10)		(1.65)	(0.15)		(2.62)		(1.89)	(1.13)
	With GDP&GDPC	0.610				-0.0575				
		(0.88)				(0.99)				
	With GDP&GDPC	0.612	0.101**			-0.0561				
		(0.88)	(2.13)			(0.97)				
	With GDP&GDPC	0.693		0.0704*	-0.00125	-0.0633				
		(0.99)		(1.89)	(0.04)	(1.09)				
	Without GDP&GDPC	-0.132					0.0289**			
		(1.10)					(2.42)			
Ln (Farm Export/GDP)	Without GDP&GDPC	-0.117	0.0814*				0.0290**	0.126		
		(0.98)	(1.75)				(2.42)	(1.34)		
	Without GDP&GDPC	-0.124		0.0591	-0.00562		0.0307**		0.108**	-0.0872
		(1.03)		(1.61)	(0.18)		(2.57)		(2.01)	(1.25)

Notes: Robust standard errors are exporter-importer clustered. *t*-statistics are in parentheses. *, **, or *** indicates significance at the 10%, 5%, or 1% levels, respectively.

Appendix Table A5: Impact of Subsidies on Exports over Farm Bills

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Outcome Variables →	Ln Farm Export	Ln Farm Export	Ln Livestock Export	Ln Livestock Export	Ln Major Crop Export	Ln Major Crop Export	Ln (Farm Export/GDP)
Farm Bill 1996	0.140**	0.118*	-0.0863***	-0.0859***	NA	NA	0.0994*
	(2.26)	(1.96)	(3.54)	(3.55)			(1.66)
Farm Bill 2002	0.232***	0.213***	0.0215	0.0190	0.371***	0.371***	0.197***
	(3.67)	(3.44)	(1.64)	(1.45)	(8.76)	(8.75)	(3.20)
Farm Bill 2008	0.134**	0.113*	-0.0159	-0.0252	0.363***	0.366***	0.0997
	(2.13)	(1.84)	(0.55)	(0.86)	(7.64)	(7.70)	(1.62)
N	29165	29165	11236	11236	19033	19033	29165
adj. R^2	0.498	0.498	0.353	0.352	0.383	0.383	0.489
LnGDP	Yes	No	Yes	No	Yes	No	No
LnGDPC	Yes	No	Yes	No	Yes	No	No

Notes: Robust standard errors are exporter-importer clustered. *t*-statistics are in parentheses. *, **, or *** indicates significance at the 10%, 5%, or 1% levels, respectively.