Impact of US Cotton Subsidies on Exports: Do the Cotton Dispute and WTO Settlement Matter?

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Abstract: This paper empirically investigates the impact of US cotton subsidization on its export by exploiting the strong within-state variation during period 2002-2012. The advancement in our identification strategy is that we address potential bias induced by "expectation error". The first source of expectation error is from program payments whose rate is unknown to producers at cultivation time. The second source of expectation error comes from uncertainty about cotton subsidy policy in near future in the context that US cotton subsidy was legally challenged by Brazil to WTO and under threat to reform. Expectation error would probably result in differences between observed subsidies and farmers' expectation about cotton payments. We utilize a unique structure of subsidy payment in year 1997 which is free from expectation error from both sources as an instrumental variable (IV) in a first differencing gravity framework. First differencing equation removes unobserved state heterogeneity and state-importer permanent differences providing a good setting for IV to address the problem of expectation error. Our results show that the effect of cotton subsidies on its exports is huge in period when subsidy policy is stable and secured as in 2002-2003 or in year 2011. On the contrary, the effect drops in size and loses its significance in periods when subsidy policy is likely to change. The effect drops to lowest level when current farm bills are due to renew. Our results also suggest that in period when future subsidy policy is gloomy, cotton growers opt to shift to other safer crops.

Key words: cotton subsidies, dispute, WTO, exports, expectation error.

1. Introduction

Although cotton accounts for a tiny proportion of income for developed countries, it is an important tradable commodity among less developed economies. For example, cotton amounts to 30% of the total exports of four West African nations: Benin, Burkina, Chad, and Mali. Revenue from cotton makes up a large proportion of income for millions of poor farmers in that region (Minotand and Daniels, 2001, cited in Sumner, 2005). Nonetheless income source for the poor from cotton revenue has been considerably shrinking as a consequence of consistently low cotton world price induced by highly distorting cotton subsidization undertaken by developed nations. Hence, cotton subsidy and particularly its distorting effect on export and production have caused a huge debate among WTO members in the context of Doha Development Agenda (DDA). US domestic support for cotton has been brought to WTO Panel from 2002 and is an ongoing challenge highlighting that cotton subsidization and policy reform are an extremely contentious issue.

In the strand of literature on our topic of interest, the price effect of subsidies on cotton's world price has been well documented in Goreux (2003), Sumner (2003b), Alston and Brunke (2006), and Anderson and Valenzuela (2006). The magnitude of the price effect is controversial and largely depends on cotton supply and demand elasticities, although generally estimates lie between 12% and 16% of the typical values of assumed elasticities. In addition, Goreux (2003) points out that once cotton subsidies by the US, EU, and China are eliminated, US cotton production will drop 16.2%. Sumner (2003b) uses a multi-country and multi-commodity simulation framework to evaluate the impact of US cotton subsidies on domestic production and export of this commodity. When domestic and export subsidies for cotton are completely removed, cotton output decreases 26.3%-27.4% while its export falls by 41.2%-43%. Anderson and Valenzuela (2006) report that the removal of domestic subsidies has a major impact on the world cotton price and welfare gain (almost 90%), leaving the impact of removing the tariff and export subsidy small at 10%. This is a distinguishing feature of cotton in that the overall agriculture domestic subsidization has a relatively small impact (5%) compared with tariffs (93%) (Anderson, Martin, and Valenzuela, 2006).

The key objective of this paper is to investigate the impact of cotton subsidy conducted in a long time period by US on its export. We exploit a strong variation in subsidy payments across states (see Figure 3) and within state over time to quantify the effect by using a modern gravity model. Figure 4-6 illustrate within state variation over sample period for Texas for which subsidy payment is largest, for Arizona with support in the middle range, and New Mexico whose payment is at the bottom among states with positive subsidy receipt. The strong variation of subsidy payment across states and within state over a reasonably long time period allows us to quantify the effect of subsidy on export. The US as world largest subsidizer for cotton, the third largest producer (behind China and India) and leading exporter of this commodity suggests that understanding the impact of its subsidization on export is important for trade negotiators and policy makers in the context of WTO settlement process.

The major contribution of this study to the existing literature is that it offers an analysis in which most updated information about the cotton dispute and its progress in WTO resolution are accumulated. More importantly, we address the problem of expectation error when identifying the effect. Expectation error may arise due to several program payments that hinge on market price at harvest time and unknown to producers at planting time including Counter Cyclical Payment (CCP) (or Average Crop Revenue Election (ACAE) program from the farm bill 2008), and marketing assistance loans. The expectation error from this source is highlighted in Kirwan (2007), RKH (2003), and Goodwin and Mishra (2006). Kirwan (2007), and RKH (2003) employ instrumental variable to address the expectation error while Goodwin and Mishra (2006) use past payments to present for payment in current year. Apart from this source of expectation error, another type of expectation error arises for cotton case. US cotton subsidy is under threat to be reformed under WTO settlement process generating an uncertainty about cotton subsidization in the coming years. These factors point out that farmers' expected subsidy payment which drive their cotton production decision may differ from actual government payments. Among studies that assess the impact of cotton subsidies on trade, Sumner (2003b) comes close to our approach in that he takes into account the problem of expectation error caused by unknown rate stimulation of program payments by using the weighted average of actual market price in the past to represent cotton growers' expectation (same as Goodwin and Mishra 2006). However, expectation error from the second source is scant in his study. Approach using past payments to present for current year's payments for price-contingent programs is unlikely to appropriate in a circumstance when expectation error from the two sources is mixed as in our case. For example confronting with the information from WTO panel that ruled against most important US subsidy provision including marketing loan gains, Counter Cyclical Payment, and Export Credit Guarantee (GSM-102 program) in December 2007 farmers may expect that these programs would be removed and no longer apply in renewed farm bill 2008. In this case using subsidies in 2007 to present for payment expectation in 2008 can lead to a very misleading inference. Follow RKH (2003) and Kirwan (2009) we utilize specialty of subsidy payment in year 1997 as an instrument to overcome the problem of expectation error.

Our regression results document that for years that subsidy policy for cotton is stable and not likely to change payments for cotton hugely promote its export while in the periods that subsidy policy is under pressure or likely to change, the effect drops and become statistically insignificant. In particular, 1% increase in cotton payment result in 2.1% increase in its export for period 2002-2003 before any information about legal challenge is perceived. During period 2004-2010 when future policy for cotton is gloomy the estimates generally decrease and lose their significance. The effect recovers to a strong level in 2011 (0.94) when current subsidy policy is insured through the mutual agreement between US-Brazil. On the other hand, due to a threat of removal from the list of major crops in renewed farm bill 2013 which indicated in the Senate-passed and House-passed proposed changes for cotton subsidization, the impact of the cotton subsidy on its export in 2002-2012 is weaker and not statistically significant.

The rest of the paper is organized as follows. Section 2 provides background on the US subsidization policy and cotton legal dispute, followed by data and descriptive statistics. The empirical framework and identification strategy is presented in Section 4 while results are analyzed in the following section. Finally Section 7 concludes this paper.

2. Institutional Background

A. Overview of US Subsidization for Cotton

US subsidization for major crops, including cotton, has a long history, since the Great Depression of the 1930s. Since then, subsidization policies have encountered a number of changes to meet the General Agreement on Tariffs and Trade (GATT)/WTO disciplines. The 1996 FAIR Act shifted subsidy programs toward "decoupled" payments that support farmers based on their historical production. From 1998 to 2000, however, a drop in market price triggered a new support called market loss assistance payment and this payment lasted through 2001 for cotton. Consequently subsidy payments surged since 1999, and for the first time, went far beyond A-Index[1] since then (see Figure 1). The Farm Security and Rural Investment Act of 2002 (FSRI Act) and the following farm bills in 2008 officially continued this payment under the name Counter Cyclical Payment (CCP), which grants subsidies on farmers' historical production when the market price falls below the price set in the statute. The 2008 farm bill introduced ACAE to ensure minimum revenue for major commodities, including cotton. It is triggered when the national price and state yield of cotton fall below a certain threshold. Producers can opt only for either ACAE or CCP.

Following Kirwan (2009) we model the estimate of subsidy payment for cotton in recent decades by the formula:

$$subsidy_{it} = \lambda_t \bar{y}_i a_{it} s_t + z_{it}.g_{it}.r_{it} \quad (1)$$

where $subsidy_{it}$ is subsidy payment for state i in year t. The first component is obtained from summing up subsidy payments across farms used in Kirwan[2] (2009). This formula

[1] The A-Index is average of the five lowest priced types of 1-3/32 inch staple length cotton on the European market from 1990 through 2008, and in Far markets in 2009.

[2] The exact formula in Kirwan is for farm i and crop j, at year t; $subsidy_{ijt} = \lambda_{tj} \bar{y}_{ij} a_{ijt} s^1_{jt}$.

presents for estimate of "decoupled" payment including DP and CCP (or market loss assistance payment in 1998-2001 or ACAE in 2008-2011). In this term λ_t is a scaling factor; $\bar{y}_i$ is average cotton yield in the period 1980-1984; a_{it} is the number of acres called base acres that qualify for subsidy and participate in year t; s_t is the national subsidy rate for cotton in year t. s_t is predetermined and set in the farm bills for DP while it depends on market price and unknown until harvest time for CCP (or market loss assistance payment in 1998-2001 or ACAE in 2008-2011). As Kirwan (2009) models land subsidy while our data is total of farm subsidy we therefore include the second component which represents for payment that base on current production. This term presents for payments including marketing assistance loans (Loan Deficiency Payment, Marketing Loan Gain, and Commodity Certificate). In this term z_{it} and g_{it} are cotton yield and base acres in current year. Meanwhile r_{it} is subsidy rate in year t which is hinge on market price and unknown to producers until marketing time. The rate may differ across states as it depends on Posted County Price of cotton. Due to strong persistence of climate pattern, characteristics of soil topology, and even cropping tradition, it is likely that current yield is highly correlated to yield in the past. Therefore z_{it} can be written as $x_{it}.\bar{y}_i$ and (1) becomes:

$$subsidy_{it} = \bar{y}_i(\lambda_t a_{it} s_t + x_{it}.g_{it}.r_{it}) \quad (2)$$

which is much the same as formulation in Kirwan (2009) in that payments across time share the same deterministic component.

B. Brazil's Challenges of U.S Cotton Subsidies at the WTO

Cotton payments during the period 1999-2001 valued at 4 billions making them double 1992 benchmark and violated Article 13 in WTO's Agreement on Agriculture.[3] Brazil, a leading cotton producers and exporters officially challenged US cotton subsidies to WTO in fall 2002. Beside prohibited export subsidies, US production subsidies for cotton are accused to distort cotton world trade and harm other cotton exporters mainly by depressing world price and allowing US to have higher market share than it would be otherwise (Sumner 2005). Brazil claimed that US cotton subsidies had distorting effect on cotton world price in period 1999-2002 and threatened to have them in the future (Sumner 2005).

After two years of initiation, in the fall of 2004, the WTO panel ruled that provisions of domestic subsidy such as CCP and price-related programs for cotton violated the WTO agreement for agricultural subsidy. Also, US step 2 payments and agricultural export credit guarantees are prohibited export subsidies under the WTO disciplines. These programs are highly likely to distort international trade and hence should be withdrawn. In 2005, the US made some changes in GSM-102 programs and step 2 payments, leaving domestic subsidy payment unchanged. Brazil, however, argued that the US response was inadequate and pursued the complaint. WTO panel ruling against US was publicly released in December 2007, and the ruling was upheld on appeal in June 2008. In August 2009, a WTO arbitration panel allowed retaliation in that Brazil was authorized to impose trade countermeasures on the US. This retaliation includes a fixed annual payment of $147.3 million and a variable annual amount based on US GSM-102 program spending.

[3]According to Article 13 domestic support measures that complied with the requirements of Agreement on Agriculture in that the level of support for a commodity remained at or below the benchmark 1992 marketing year (MY) levels are exempted from being challenged as illegal subsidies through dispute settlement processing.

Furthermore, cross-retaliation may also apply in the US copyright and patent areas. To avoid the threat of retaliation, the US and Brazil entered a temporary mutual agreement in June 2010. The agreement includes (1) US annual payment of $147.3 million to the Brazilian Cotton Institute to provide technical support to Brazil's cotton industry, (2) regular discussions on limits of the US trade-distorting subsidy for cotton, and (3) modifications to the GSM-102 guarantee followed by semi-annual reviews. The actual changes for cotton subsidization necessary to limit its distortion on trade, as in (2) above, however, would not be implemented until the next farm bill not earlier than 2012. Furthermore, proposed changes for cotton subsidization were agreed upon in both the Senate-passed and House-passed 2013 farm bill. The key point of those proposed changes included removing cotton from the list of major commodities that receive price and income support. Instead, a stand-alone, county-based revenue insurance policy called the Stacked Income Protection Plan (STAX) would be delivered. The mutual agreement and proposed changes in US cotton policy since 2010 are more adequate, significant and generate a more firmness and validity compared with changes in 2005. This implies that US's response in this period reduced the expectation error from uncertainty of policy changes to a larger extent compared with 2005 changes.

3. Data and Descriptive Statistics

Chapter 1 and 2 use exports and imports data of 46 US states[4] with the 100 biggest trading partners, which accounts for 98% of the US total trade (sum of imports and exports). However for cotton commodity, only 16 states grow cotton and accordingly

[4] Alaska, North Dakota, South Dakota, Wyoming, the District of Columbia, are excluded from the sample as their trade flows are negligible. These regions together account for less than 2% of the total US cotton trade value.

receive subsidies for the whole period while the rest does not receive payment in all years[5]. This is because cotton is a special crop and requires specific conditions to develop. Some states that receive no cotton support but have positive export value during the sample period. This happens as cotton exports encompass all primary and processed cotton products. Some states do not grow cotton but can import raw cotton from other states and export processed and other cotton based products. Nonetheless export value from non-production states account for only 2.8%. Thus in our analysis the sample is restricted to 16 states with positive cotton receipt.

Cotton export data are extracted from the Harmonized System at the 6-digit level from *USA Trade Online*. Data on domestic subsidies per annum for each state are obtained from the Farm Subsidy Database of the Environmental Working Group (EWG).[6] In the model we control for standard gravity variables including gross domestic product (GDP) whose data are collected from the US Department of Commerce (Bureau of Economic Analysis). Data on landborder and coastline of US states are collected from online sources such as Wikipedia. Finally, the bilateral distance between one state and its trading partner is the flight distance between two corresponding capital cities and representing for transaction cost calculated by the author using the website Worldatlas.

Descriptive statistics for the main variables are presented in Table 1. On average, states that receive subsidies annually exports approximate $3.4 million of cotton products. The value of the average cotton subsidy receipt is more than 37 times higher than that at $126.14 million. In addition, states receiving the largest amount of support

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[5] This should happened longer time before our sample started, at least from 1980 as if a state grew cotton from this year onward PFC or DP should be positive.

[6] The EWG database can be accessed via the following link: farm.ewg.org.

include Texas with annual payment of $687 million, Mississippi with $269 million, and California with two-thirds of Mississippi's payment. Likewise annual export value among these states is double the average level of all 16 states. The subsidy granted also differs across years. For instance, the average subsidy payment is almost 8 times higher in 2005 than in 2012. In short, statistics show that cotton exports, and subsidy payments differ substantially across states and time and that there is a positive association between cotton receipt and its export value.

4. Empirical Strategy—Identification

4.1 Unobserved Heterogeneity

To evaluate the impact of cotton subsidy on export, I use the gravity model as follows:

$$Ln(V_{ijt}) = a_{jt} + b_i + c_{rt} + \alpha Ln(subsidy^{*}_{it}) + \beta Z_{ijt} + \varepsilon_{ijt} \quad (2)$$

where V_{ijt} is export value from state *i* to importer *j* in year *t*. $subsidy^{*}_{it}$ is the variable of interest representing subsidy value granted by state *i* in year *t*. This figure is likely to differ from producers' expectation about the payment for which we denote $subsidy_{it}$. Z_{ijt} is a vector of standard gravity model as described.[7] Vector of importer by year interaction, a_{jt}, is used to account for importers' characteristics over time.[8] More importantly, state dummies are included to capture productivity-related factors which might be associated with both subsidy payments and cotton export capability. This is because US geography is diversified so several states are blessed with climate patterns

[7] When state specific factors are included, *coastline* is droped from this vector due to multi-collinearity.
[8] This releases the demand for using 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). Adding these dummies also addresses the problem of "multilateral resistance" from the importer side which will bias gravity coefficient estimates if not accounted for (See Anderson and Van Wincoop, 2004 for a discussion).

and soil topology which is more suitable and favorable for agricultural production than others. Further more, subsidy programs paid on historical production such as DP vary little over time making them highly correlated with state permanent characteristics. State-specific dummies also capture the potential endogeneity of the subsidy in case the federal government sets export achievement as a hidden target behind the visible target of supporting farmers' income.[9] In both these possibilities, the effect of the cotton subsidy is likely to bias upward as these unobservable factors have a positive correlation with both the cotton subsidy payment and cotton's export. Recall that in chapter 1 when state specific factors are controlled for, the effect of subsidy declines more than five times and DP is the main source of this reduction. Similar to chapter 1, we also include region year interaction indicators as subsidies for cotton include programs that may share a common for states within a region. For example, natural disasters or pet disease, when happens, seem to affect a whole region including states nearby each other rather than an individual state. Such incidences influence both subsidy payments such as disaster payments or crop insurance and export at the same time. In addition they also capture any spillover effect within a region which may result from interstate trade and re-export. This evidences in our sample as several states have positive export values while they do not produce cotton at all.

The estimating equation in this study is the first differencing of equation (2); time-invariant variables, including distance, land border, and state-specific factors, are dropped, resulting in[10]:

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[9] Like vector of importer year interaction, this set of dummies reduces the multilateral resistance from the state side.

[10] It is worth highlighting that equation (3) absorbs all exporter-importer specific factors along with distance and land border. For example, this vector of dummies takes into account potential omitted

$$\Delta Ln(V_{ij}) = a_j + d_r + \alpha \Delta Ln(subsidy_i^*) + \beta \Delta Ln(GDP_i) + \Delta \varepsilon_{ij} \quad (3)$$

4.2. Expectation Error

The most significant obstacle to overcome in identifying the effect of the cotton subsidy on its export is the attenuation bias. This type of bias can come from two sources. First, the cotton dispute and WTO settlement may have an impact on farmers' perspective on the cotton subsidy in the investigated period. Second, with the farm bill of 2002, although subsidy rates are set in the legislation, the actual rate of payments for a number of programs including marketing assistance loans, CCP, and ACAE is not determined until harvest time. The contingency of payment on market conditions at harvest time and the uncertainty regarding the policy changes due to the WTO settlement would likely result in expectation error. Producers do not know about the next year's payment at the time of cultivation. Their expectation about the support itself would drive their incentives for cotton growing. If producers have a gloomy prediction about the cotton subsidization policy, they would probably shift to other more compelling commodities. Otherwise, they would engage in cotton cropping and/or expand their production. The observed cotton government payment, thus, would probably differ from farmers' expectation, resulting in

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variables such as an export subsidy, which is substantially used in the case of cotton in the investigated period. It is likely that the export subsidy has a positive correlation with the domestic subsidy. This correlation stems from the fact that the export subsidy can be used as a means to push extra production resulting from a domestic subsidy into the world market (Chokeman, Francis, and Olarreaga, 2004). An export subsidy is often offered in the form of export tax reduction/exemptions, support for product marketing, or entitlement to credit access. An export subsidy is normally destination-specific as it targets the most potential importers. The targeted export subsidy destinations may be changed over time, although this is rare. So, the export subsidy can be considered a pair-specific variable and that is why it can be captured by the vector of state-importer dummies. If so, not controlling for this omitted variable would lead to an upwardly biased estimate of the subsidy effect. Furthermore, the set of exporter-importer dummies also tackles the problem of multilateral resistance related to the pair of countries in the sample. Finally, note that the tariff is not included in the model as our data are at the state level, so the tariff for a given destination and year is the same for all states. In addition, any variation in the tariff is partially captured by the importer-year and exporter-importer fixed effect.

errors in variables. Actual cotton subsidy payments will equal the expected government payment and the expectation error, that is,

$$subsidy_{it} = subsidy^{*}_{it} + \varepsilon^{g}_{it} \quad (4)$$

Similar to Kirwan (2009), we also assume that the expected subsidy and the expectation error are uncorrelated, that is, $Cov(subsidy^{*}_{it}, \varepsilon^{g}_{is}) = 0$ for all t; s implies that using the observed government payment instead of expected payments would lead to the problem of classical errors in variables, namely, attenuation bias. This would bias OLS estimate downward when expected sign is positive as in this situation (Wooldridge, 2002, p.75). RKH (2003) and Kirwan (2009) utilize a unique structure of subsidy payment in 1997 to address the problem of error-in-variables. 1997 was the first year when the Fair Act 1996 which devoted subsidy payments with current production and market price was signed into law. Because payments in 1997 almost came from PFC for which the rate is predetermined set in the Fair Act 1996, 1997 payment should contain little or no expectation error (from second source in our category, RKH 2003, Kirwan 2009). According to RKH (2003) and Kirwan (2009) another characteristic of this variable that makes it a qualified instrument is that subsidy payments in the period were estimated with the same deterministic component $\bar{y}_i$ as in equation (1). In our case this variable should not bear expectation error from the first source as it was 5 years prior the cotton case's initiation and it correlated with subsidy payments in other years through deterministic component $\bar{y}_i$ as in equation (2). We therefore use the same instrument variable, 1997 subsidy payments, to address the problem of expectation error as in RKH (2003), and Kirwan (2009).

Expected and actual payment differences for 2002 and year t (with t from 2002 to 2012) can be written as $subsidy_{i,2002} = subsidy^{*}_{i,2002} + \varepsilon^{g}_{i,2002}$ and $subsidy_{it} = subsidy^{*}_{it} + \varepsilon^{g}_{it}$. Substituting each of these two years in equation (3) yields the estimating equation for period from 2002 to year t as[11]:

$$\Delta Ln(V_{ij}) = a_j + d_r + \alpha\left(Ln(subsidy_{i,t}) - Ln(subsidy_{i,2002})\right) + \beta\Delta Ln(GDP_i) + \Delta\varepsilon_{ij} + \left(\varepsilon^{g}_{i,t} - \varepsilon^{g}_{i,2002}\right) \quad (5)$$

As analyzed earlier, 1997 subsidy payments could be a qualified instrument to address the problem of error-in-variable only when state permanent differences are taken into account. It means that this variable may not be appropriate for specifications without controlling for state specific factors, or for cross sectional analysis. As in equation (2), if state fixed effect b_i is not controlled for, the composite error can be presented as $u_{ijt} = b_i + \varepsilon_{ijt}$. As a large part of 1997 subsidy payment comes from PFC which paid on historical production, it should have high correlation with b_i and hence endogenous itself. According to Woodridge (2002, p.102), 2sls estimators when instrumental variable is endogenous have plim:

$$p\lim_{2sls} = \alpha + \left(\sigma_u / \sigma_{lsubsidy_t}\right)\left[Corr(lsubsidy_{1997}, u) / Corr(lsubsidy_{1997}, lsubsidy_t)\right]$$

Meanwhile OLS has plim:

$$p\lim_{OLS} = \alpha + \left(\sigma_u / \sigma_{lsubsidy_t}\right) Corr(lsubsidy_t, u)$$

Therefore if payments in year t and 1997 have high correlation with each other and both have high correlation with b_i as in this case, 2sls and OLS estimators can be similar in a finite sample.

[11] We do the same way for estimates of 2002-2012 period.

5. Estimation Results and Discussion

5.1. Impact of Cotton Subsidies on its Exports

To see the specification for which the IV works well, we first present OLS and IV estimate for each year from 2002 to 2012 using specification (2) without state specific dummies. As can be seen from Table 2 Panel A, the estimate of subsidy is consistently high from 0.47 to 0.92 and strongly significant at 1% level. IV estimates are very similar with OLS estimates implying that error-in-variable is not a problem or that IV fails to detect it. We favor the second possibility as we pointed out in the previous section that similarity of OLS and IV estimates might result from the fact that IV does not perform well in cross sectional estimate as itself correlates with omitted state specific factors in error term. In addition, partial R-squared (and hence F-statistics) from the first stage is incredibly high indicating that payments in 1997 and other years are substantially correlated (93% to 99% for most years). The correlation almost reaches 100% for most years is too high as PFC accounted for most of payment in 1997 while for other years, payments which hinge on current market conditions and production contribute to around half of total payments. It is likely that they have such high correlation because they both highly correlate with state permanent characteristics which are not accounted for in cross sectional estimates.

Next we take advantages of longitudinal data nature to minimize the problem of simultaneity and omitted variables, allowing an environment for which IV might be powerful in addressing the problem of error-in-variable. In Table 3 we report estimates for all periods from 2002 to year t with t from 2003 to 2012. Panel A reports pooled OLS for each of these periods while fixed effect (FE) and first differencing estimate (FD) (between year t and 2002) are presented in panel B and C respectively. First differencing with IV estimate (FDIV) is in panel D. The effect from pooled OLS estimators is even higher than cross sectional estimate and strongly significant for all periods. When state specific factors are accounted for, FE and FD immediately drop in size, lose their statistical significance for almost all periods, and have negative sign in several cases. This movement is consistent with what we predict before in that subsidy payments especially PFC, and DP have positive correlation with permanent state characteristics. However when error-in-variable exists, FE or FD tend to be downwardly biased toward zero. When IV is used to overcome the problem of error-in-variable, estimate for all periods become positive, larger though only statistical sometimes. It is worth highlighting that partial R-squared from the first stage after netting out state specific factors reduce 8-9 times in size verifying our earlier projection that subsidy in year 1997 and year from 2002 to 2012 have high correlation with state permanent characteristics. Nonetheless, the correlation between these subsidy payments is high with F-statistics strongly rejects the null hypothesis at 1% level in all cases suggesting that the IV is sufficiently strong.

We can observe an interesting pattern of the subsidy effect from FD with IV. The effect is largest at 2.1 and strongly significant for the period 2002-2003. Recall that the cotton case is initiated in the late 2002, thus the information that cotton subsidy policy is legally challenged and might be subjected to reform is unlikely to be publicly recognized and to cause adverse effect on producers' decision in cotton cultivation time in March and June for the year 2003. In addition very high effect of subsidies found for this period can be explained as a result of an increasing trend of cotton subsidies in period from 1998-2001 (Figure 2). It is also clear from Figure 2 that price-support programs that hinges on market conditions and unknown to producer at cultivation time (payments subjected to error-in-variable from first source) including Market Loss Assistance, MLG, CC, and LDP) continue to increase and get extremely large in 2001. If farmers expect that payments of these programs in this year (2002 or 2003) continue the trend in recent years, the effect of subsidies on production should be large as we observed. In year 2004, however, when producers for the first time are hit by the bad news they may react too strong making the effect reduces 9 times in size. However, from the period 2005 to 2010 (except 2008) it seems that producers adapt their behavior basing on the fact that US government has taken series of actions to protect domestic producers and that it may take long time for a legal process to be settled. The effect in these periods recovers with magnitude from 0.68 to 1.5 though only statistically significant for the year 2009. The only difference in this period is a very low estimate in year 2008 at 0.22 (with t-statistic=0.3). As 2008 is the time for farm bill to be renewed, farmers' worriness about disadvantageous changes in cotton subsidies in a complicated situation when subsidization policy for cotton is under pressure to reform is understandable. The US-Brazil mutual agreement in year 2010 confirms that actual changes would not occur until farm bill 2008 due in 2012 provides a guaranty about subsidy payments in year 2011. The effect in this year is high at 0.94 and statistically at 5% level. However, when time for disadvantageous proposed changes (Senate-passed and House-passed proposal in 2010 that cotton is removed from eligible crops in renewed farm bill) was nearing and the current farm bill 2008 is due in year 2012, the magnitude of subsidy effect reduces more than half and loses its significance.

5.2. Potential Explaination for Cotton Growers' Behavior When Future Cotton Subsidies are Gloomy

In period from 2004 to 2010 subsidy policy for cotton confronts disadvantages and is under pressure to reform while in year 2002, 2003, and 2011 there is an insurance in subsidy payments. Accordingly we find a large reduction in subsidy effect when subsidy policy in the foresee future is gloomy. A common behavior of cotton growers is that they would shift their production toward other crops in the period 2004-2010. We test this possibility by estimating the effect of farm subsidies on exports after subtracting subsidies and exports for cotton in total value. As for agricultural products without cotton, only expectation error from the first source (subsidy rates are unknown to producers at harvest time), we estimate specification (2) and use payments in the past to present for producers' expectation in current year (similar to Goodwin and Mishra 2006, and Sumner 2003b). The estimate in Table 4 columns (1) to (3) allows information in previous 1, 2, and 3 years to present for current payments. The results in columns (2) and (3) shows that in years from 2004-2010 when there are uncertainty and disadvantages about future policy changes for cotton, the effect of subsidies on agricultural exports (excluding cotton) is stronger than in the other years. The results support our prediction that during the period 2004-2010, cotton growers shift their production toward safer commodities.

5.3. Robustness Check

As in Deadroff's (1985) 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 subsidy coefficients are driven by omitting this variable, we include it in the model. The results with GDPC included reported in Table 5 largely the same indicating that the effect deems robust to this version of gravity model.

6. Conclusion

Cotton is one of the commodities that has received the largest amount of support in industrialized countries. This crop makes up a tiny fraction of these rich countries' income while it constitutes a meaningful proportion of GDP and is the most important cash crop for a number of least developed countries especially those in West and Central Africa. As the world's third largest producer and the leading exporter of cotton, the US has granted a huge amount of support to domestic cotton growers, which is believed to have suppressed the world price by stimulating excessive production. In addition, there was no reducing tendency in the level of support through the renewed farm bills in recent decades when agricultural subsidization had been brought to GATT rounds. Thus, US cotton subsidization has given rise to extreme debate. The policy ended up being challenged at the WTO by Brazil in 2002 when US subsidization policy for cotton no longer can seek for protection from WTO, and the settlement process was long lasting. In this context, a study on the impact of cotton subsidization on its exports is crucial. This study provides insight into these effects for the period when the debate and its resolution were still alive. We address the problem of error-in-variable from program payments that are unknown to producers at cultivation time and from expectation when the policy is likely to change. We report a large effect of cotton subsidization on its export in period for which subsidy policy for cotton is stable and secured. US cotton exports would shrink at double rate of subsidy reduction in pre-challenged period or at almost equal rate in 2011 when validity of current subsidy policy was stated in the US-Brazil mutual agreement signed in late 2010. The effect is 2-5 times larger than that found in Sumner (2003b). This is likely because we address the problem of expectation error caused by uncertainty of subsidy policy. Compared with the effect of subsidies on agricultural export value in chapter 1, the effect is 10-15 times higher for cotton. Our finding is in line with Anderson, Martin, and Valenzuela (2006) when they find that welfare impact of cotton subsidies is 9 times higher than that from tariff and export subsidy while the size of impact is around 1/19 for agricultural commodities. Nonetheless in years from 2004-2010 when cotton was officially challenged and the dispute was stretching, the effect went down significantly, and lose their significance in most years except 2009. In addition, the effect drops most substantially in years when producers first hit by bad information (2004), or the time when current farm bills are due and ready to be renewed (2008, 2012). Evidences suggest that producers shift their production toward other safer crops in the period when cotton policy is gloomy.

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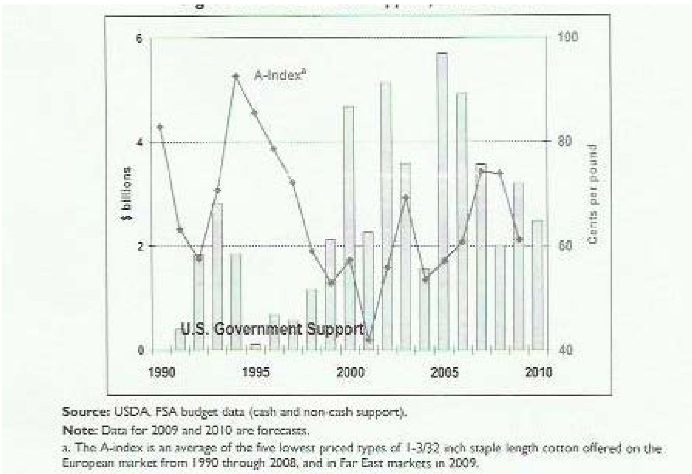
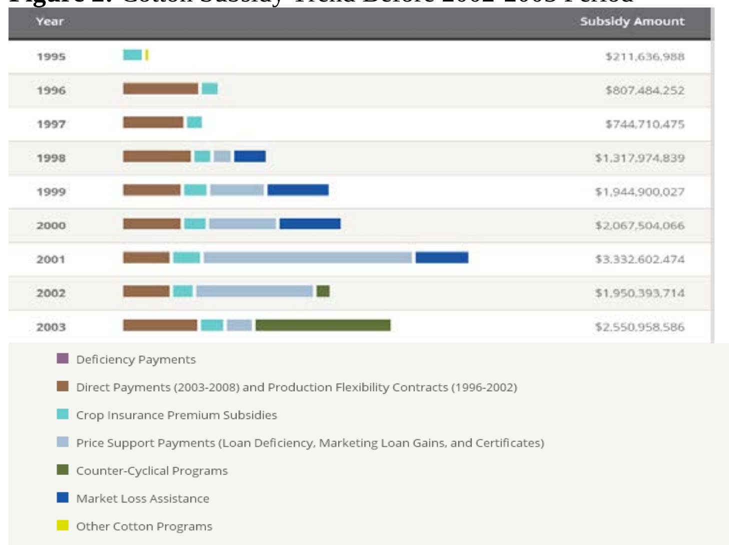
Figure 1: USDA Cotton Support 1992-2010



Source: Congressional Research Service (Schnepf, 2010)

Figure 2: Cotton Subsidy Trend Before 2002-2003 Period



Source: Environmental Working Group

Figure 3: Cotton Subsidy among States with Positive Payment

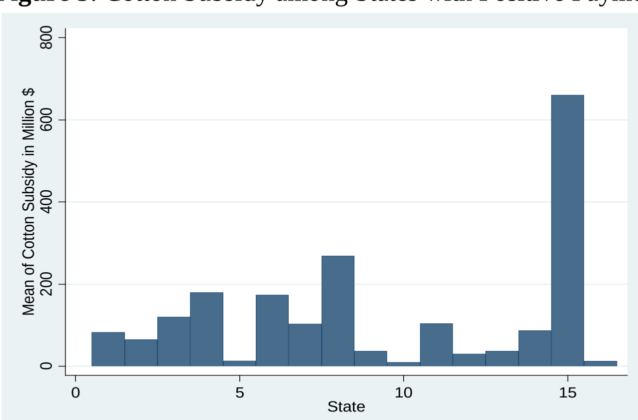


Figure 4: Cotton Subsidy for Texas over Time

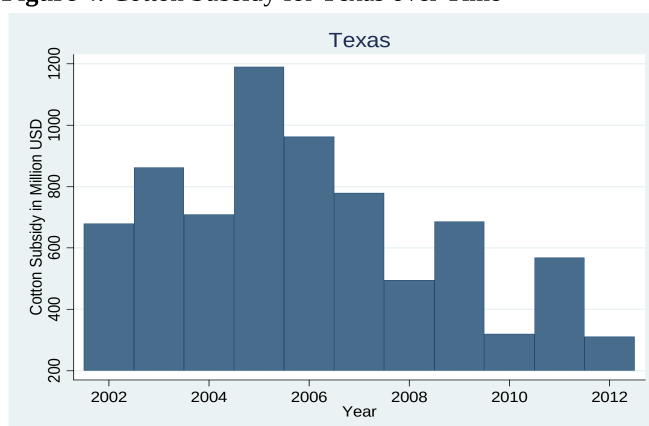


Figure 5: Cotton Subsidy for Arizona over Time

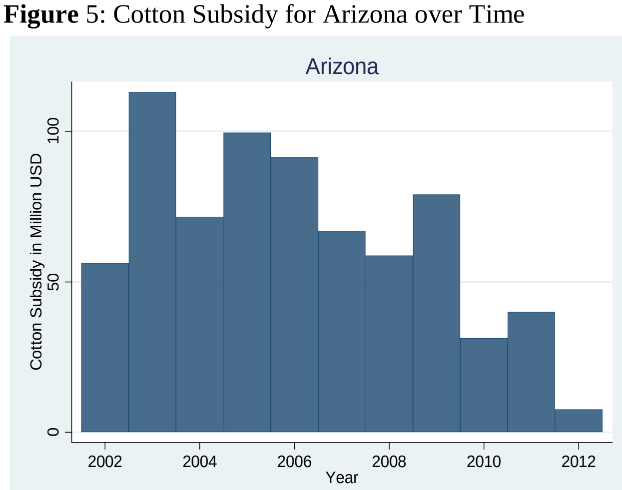


Figure 6: Cotton Subsidy for New Mexico over Time

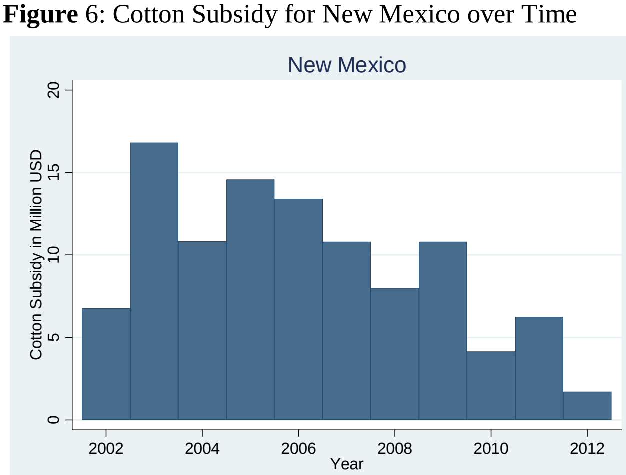


Table 1: Descriptive Statistics for Main Variables 2002-2012

	Log(Cotton Exports$_{ijt}$)				Log(Cotton Subsidies$_{it}$)			
Time	Mean/sd	Min	Max	N	Mean/sd	Min	Max	N
From 2002-2012	3399367.3 (26233929.1)	0	1.08998e+09	17600	126139001.0 (183627906.1)	1691584.8	1189801088	17600
Year 1997					17.22 (1.172)	14.88	19.51	1600
Year 2002	12.91 (2.531)	7.945	19.84	661	17.98 (1.272)	15.73	20.34	1600
Year 2003	13.08 (2.649)	7.914	20.06	643	18.42 (1.058)	16.64	20.57	1600
Year 2004	13.17 (2.698)	7.879	20.53	627	18.19 (1.170)	16.20	20.38	1600
Year 2005	12.98 (2.751)	7.824	20.46	583	18.57 (1.230)	16.49	20.90	1600
Year 2006	13.05 (2.693)	7.844	20.64	607	18.40 (1.154)	16.41	20.68	1600
Year 2007	13.12 (2.674)	7.780	20.20	674	18.18 (1.199)	16.20	20.47	1600
Year 2008	13.05 (2.670)	7.767	20.39	656	17.79 (1.071)	15.89	20.02	1600
Year 2009	12.86 (2.629)	7.762	19.65	652	18.14 (1.092)	16.19	20.35	1600
Year 2010	13.02 (2.792)	7.781	20.47	660	17.13 (1.103)	15.18	19.59	1600
Year 2011	13.34 (2.929)	7.720	20.81	637	17.43 (1.088)	15.52	20.15	1600
Year 2012	13.11 (2.778)	7.710	20.51	614	16.17 (1.189)	14.34	19.55	1600

Note: Descriptive statistics is calculated for 16 states with positive subsidy payments.

Table 2: OLS and IV Cross Sectional Estimates

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Time→	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**
Panel A: OLS											
Log(Cotton Subsidies$_{it}$)	0.659***	0.920***	0.737***	0.685***	0.796***	0.583***	0.650***	0.547***	0.502***	0.727***	0.474***
	(8.21)	(9.06)	(7.78)	(6.88)	(7.37)	(7.02)	(6.78)	(6.07)	(5.79)	(6.88)	(4.53)
Log(Distance$_{ij}$)	-2.131***	-2.251***	-2.097***	-2.069***	-1.867***	-1.501***	-1.476***	-1.959***	-1.609***	-1.976***	-1.017
	(4.56)	(4.39)	(4.52)	(4.61)	(3.78)	(3.51)	(2.77)	(3.15)	(2.96)	(3.37)	(1.31)
Log(GDP$_{it}$)	0.301	-0.080	-0.109	-0.100	-0.019	0.365**	0.392*	0.601***	0.725***	0.605***	0.895***
	(1.63)	(0.37)	(0.50)	(0.44)	(0.09)	(2.11)	(1.92)	(3.33)	(3.96)	(2.91)	(4.76)
Border$_i$	0.674	1.107*	0.444	-0.443	-0.592	0.491	0.858	-0.308	-0.347	2.079**	2.946***
	(1.07)	(1.91)	(0.91)	(0.34)	(0.64)	(0.61)	(1.08)	(0.24)	(0.22)	(2.26)	(2.75)
Coastline$_i$	-0.193	0.918*	1.187**	1.587***	1.245**	0.334	-0.095	-0.268	-0.695	-1.545***	-1.383***
	(0.41)	(1.95)	(2.41)	(3.07)	(2.30)	(0.75)	(0.21)	(0.62)	(1.56)	(3.40)	(2.97)
Number of Observations	661	643	627	583	607	674	656	652	660	637	614
Adjusted R-Squared	0.562	0.546	0.565	0.553	0.569	0.645	0.599	0.641	0.647	0.620	0.597
Panel B: IV											
Time→	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**
Log(Cotton Subsidies$_{it}$)	0.669***	0.922***	0.716***	0.609***	0.718***	0.517***	0.670***	0.535***	0.509***	0.759***	0.598***
	(8.29)	(9.70)	(8.09)	(6.80)	(7.09)	(6.80)	(7.42)	(6.29)	(6.18)	(7.19)	(5.15)
Log(Distance$_{ij}$)	0.289*	-0.082	-0.089	-2.009***	-1.812***	-1.444***	-1.487***	-1.950***	-1.613***	-1.986***	-1.027
	(1.65)	(0.42)	(0.44)	(4.97)	(4.06)	(3.66)	(3.02)	(3.39)	(3.21)	(3.66)	(1.43)
Log(GDP$_{it}$)	-2.140***	-2.253***	-2.080***	-0.027	0.043	0.431***	0.373**	0.611***	0.719***	0.576***	0.812***
	(4.93)	(4.74)	(4.89)	(0.13)	(0.22)	(2.69)	(1.99)	(3.62)	(4.24)	(2.98)	(4.69)
Border$_i$	0.669	1.106**	0.453	-0.404	-0.560	0.535	0.838	-0.301	-0.349	2.049**	2.931***
	(1.15)	(2.06)	(1.00)	(0.33)	(0.65)	(0.71)	(1.14)	(0.25)	(0.24)	(2.38)	(3.11)
Coastline$_i$	-0.190	0.919**	1.181***	583	1.244**	0.337	-0.091	-0.269	-0.695*	-1.540***	-1.441***
	(0.43)	(2.11)	(2.60)	0.553	(2.49)	(0.81)	(0.21)	(0.68)	(1.69)	(3.67)	(3.32)
Number of Observations	661	643	627		607	674	656	652	660	637	614
Adjusted R-Squared	0.562	0.546	0.565		0.569	0.645	0.599	0.641	0.647	0.620	0.595
Partial R-Sq	0.85	0.97	0.97	0.93	0.96	0.97	0.99	0.99	0.97	0.90	0.71
F-Statistics	5344.66	21883.5	37000.9	10248.9	27140.7	20891.6	47776	28437.7	15308.3	4046.11	965.31

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: First Differencing and First Differencing with IV Estimates

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Time→	**2002-2003**	**2002-2004**	**2002-2005**	**2002-2006**	**2002-2007**	**2002-2008**	**2002-2009**	**2002-2010**	**2002-2011**	**2002-2012**
Panel A: Pooled OLS										
Log(Cotton Subsidies$_{it}$)	0.763***	0.755***	0.740***	0.750***	0.718***	0.708***	0.688***	0.665***	0.672***	0.650***
	(9.83)	(10.20)	(10.68)	(11.06)	(11.10)	(11.23)	(11.18)	(11.21)	(11.38)	(11.23)
Log(Distance$_{ij}$)	-2.187***	-2.156***	-2.132***	-2.088***	-1.994***	-1.925***	-1.927***	-1.885***	-1.900***	-1.811***
	(5.13)	(5.34)	(5.43)	(5.34)	(5.31)	(5.06)	(4.91)	(4.80)	(4.89)	(4.48)
Log(GDP$_{it}$)	0.128	0.052	0.015	0.010	0.074	0.122	0.184	0.253*	0.290**	0.354***
	(0.73)	(0.31)	(0.10)	(0.06)	(0.51)	(0.86)	(1.36)	(1.93)	(2.24)	(2.78)
Border$_i$	0.897	0.744	0.438	0.229	0.268	0.334	0.249	0.189	0.342	0.591
	(1.56)	(1.45)	(0.75)	(0.36)	(0.41)	(0.51)	(0.35)	(0.24)	(0.43)	(0.75)
Coastline$_i$	0.337	0.605	0.815**	0.896**	0.788**	0.654*	0.533	0.379	0.179	0.020
	(0.81)	(1.53)	(2.17)	(2.41)	(2.22)	(1.91)	(1.62)	(1.20)	(0.57)	(0.06)
Number of Observations	1304	1931	2514	3121	3795	4451	5103	5763	6400	7014
Adjusted R-Squared	0.552	0.558	0.557	0.559	0.575	0.578	0.586	0.593	0.595	0.594
Panel B: Fixed Effect										
Log(Cotton Subsidies$_{it}$)	0.952***	0.321	0.346*	0.159	0.045	-0.104	0.139	0.079	0.124	0.001
	(2.94)	(1.60)	(1.85)	(0.91)	(0.28)	(0.69)	(0.93)	(0.55)	(0.90)	(0.01)
Log(Distance$_{ij}$)	-2.194***	-2.098***	-2.083***	-2.072***	-2.007***	-2.001***	-2.018***	-2.014***	-2.065***	-2.020***
	(5.08)	(5.33)	(5.30)	(5.26)	(5.33)	(5.26)	(5.17)	(5.21)	(5.40)	(5.05)
Log(GDP$_{it}$)	-42.311***	-8.075*	-7.349**	-5.390**	-4.265**	-1.438	0.859	0.097	-0.008	-0.511
	(2.96)	(1.69)	(2.18)	(2.24)	(2.14)	(0.78)	(0.53)	(0.07)	(0.01)	(0.37)
Border$_i$	0.310	0.236	-0.004	-0.267	-0.177	-0.110	-0.177	-0.204	-0.040	0.178
	(0.56)	(0.46)	(0.01)	(0.40)	(0.26)	(0.16)	(0.24)	(0.25)	(0.05)	(0.23)
Number of Observations	1304	1931	2514	3121	3795	4451	5103	5763	6400	7014
Adjusted R-Squared	0.612	0.615	0.608	0.611	0.619	0.622	0.626	0.630	0.630	0.629
Panel C: First Differencing										
Log(Cotton Subsidies$_{it}$)	0.717**	0.200	-0.697	-0.581**	-0.188	-0.314	0.358	0.004	0.296	0.007
	(2.40)	(0.73)	(1.36)	(2.05)	(0.55)	(1.31)	(1.21)	(0.02)	(1.41)	(0.05)
Log(GDP$_{it}$)	-34.407***	-8.683*	-15.742***	-9.515***	-5.571	-1.645	1.264	-3.658	-3.754	-3.959
	(2.59)	(1.72)	(2.89)	(2.79)	(1.30)	(0.46)	(0.39)	(1.22)	(1.32)	(1.04)
Number of Observations	540	527	494	498	522	517	509	501	486	484
Adjusted R-Squared	0.092	0.090	0.083	0.126	0.215	0.207	0.231	0.280	0.315	0.278
Panel D: FDIV										

Log(Cotton $Subsidies_{it}$)	2.092***	0.241	1.532	0.800	1.071	0.216	1.252**	0.680	0.937**	0.388
	(2.81)	(0.16)	(1.30)	(1.04)	(1.03)	(0.30)	(2.11)	(0.98)	(2.00)	(0.87)
Log(GDP_{it})	-83.581***	-8.726*	-5.290	-4.981	2.482	1.594	7.233	0.538	-0.375	0.600
	(2.92)	(1.73)	(0.72)	(1.20)	(0.35)	(0.31)	(1.61)	(0.11)	(0.11)	(0.10)
Number of Observations	540	527	494	498	522	517	509	501	486	484
Adjusted R-Squared	0.039	0.089	0.040	0.080	0.188	0.197	0.212	0.265	0.299	0.268
Partial R-Sq	0.14	0.03	0.19	0.15	0.08	0.1	0.2	0.13	0.18	0.11
F-Statistics	33.50	13.05	136.3	70.61	52.43	54.45	190.18	55.3	51.83	28.43

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: Potential Explanation for Cotton Growers During the Sample Period

	FE		
Dependent Variable→	Log(Farm Export-Cotton Export)	Log(Farm Export-Cotton Export)	Log(Farm Export-Cotton Export)
Log($Distance_{ij}$)	-2.165***	-2.101***	-2.072***
	(7.82)	(7.57)	(7.38)
Log(GDP_{it})	0.322	0.244	-0.564
	(0.47)	(0.29)	(0.57)
$Border_i$	0.491	0.504	0.500
	(0.97)	(1.01)	(0.99)
Log(Cotton $Subsidies_{i(t-1)}$) in years 2002, 2003, and 2011	0.332***	0.068	0.184
	(3.11)	(0.38)	(0.74)
Log(Cotton $Subsidies_{i(t-1)}$) in years from 2004-2010	0.323***	0.310**	0.368**
	(2.98)	(2.16)	(2.20)
Log(Cotton $Subsidies_{i(t-2)}$) in years 2002, 2003, and 2011		0.176	0.438
		(0.75)	(1.51)
Log(Cotton $Subsidies_{i(t-2)}$) in years from 2004-2010		-0.010	0.128
		(0.08)	(0.83)
Log(Cotton $Subsidies_{i(t-3)}$) in years 2002, 2003, and 2011			-0.274
			(0.63)
Log(Cotton $Subsidies_{i(t-3)}$) in years from 2004-2010			-0.087
			(0.72)
Number of Observations	18446	16624	14714
Adjusted R^2	0.423	0.418	0.418

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: Estimate the Effect Using an Alternative Gravity Model

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Time→	**2002-2003**	**2002-2004**	**2002-2005**	**2002-2006**	**2002-2007**	**2002-2008**	**2002-2009**	**2002-2010**	**2002-2011**	**2002-2012**
Log(Subsidies)	2.236***	0.255	1.569	0.795	0.839	-0.006	1.252**	0.570	0.887**	0.344
	(2.59)	(0.14)	(1.32)	(1.12)	(0.95)	(0.01)	(2.11)	(0.97)	(2.12)	(0.96)

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