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U.S. Cotton Subsidies: Drawing a Fine Line on the Degree of Decoupling

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The impact of the U.S. cotton policy depends on several interrelated factors: how input subsidies interact with producer price supports, producer price expectations, and the extent to which price supports are decoupled from production. Cotton subsidies have a direct impact on world cotton prices, depending on the extent to which price supports are coupled to production. At one extreme, there is a price impact of 12.4% when producers make decisions at the loan rate, but the average price impact is 20.9% when producers make decisions based on the target price. Results are presented for intermediate cases of decoupling.

Key Words: cotton, counter-cyclical payments, decoupling, loan rate

JEL Classifications: Q17, Q18, Q25, Q28

Global interdependence in the digital age has resulted in the creation of many new and important trade linkages, trade associations, and trading agreements. As global trade has increased, however, so has the recrimination and incidence of trade disputes. The Canadian investigation into U.S. corn dumping complaints (Elliott) offers a simple example of cross-border friction in the trade of feed grains. Additional tensions on a wider international scale are exemplified by the separate cases that Brazil has brought to the World Trade Organization (WTO); one in which European Union sugar policy is targeted (Powell and Schmitz 2005), and the other being their successful suit against subsidies provided by the government of the United States to the U.S. cotton industry. These challenges have not only highlighted the North–South contention over agricultural trade concessions, but they also illustrate the intense nature of trade issues and negotiations; the ramifications of which can have severe consequences for producers, consumers, and governments worldwide. For example, the WTO decision has important implications for the future of a new U.S. farm bill. Also, because of its high profile defeat in the WTO, debate over the U.S. cotton program has been reignited in academic circles, with the subsequent examination of the alleged economic inefficiencies and rent-seeking behavior resulting from trade-distorting agricultural policies.

In this paper, even though we specifically model the impact of U.S. cotton subsidies on the world price of cotton, this model has applicability to U.S. agricultural policy in general. This paper builds on earlier work by Schmitz, Schmitz, and Dumas and Rossi, Schmitz, and Schmitz. The model is comparative static in nature and reflects the main policy instruments affecting U.S. cotton production, exports, and world prices. The two previous papers modeled the U.S. cotton

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market under the strong assumption that cotton producers base their production on the target price set forth under the U.S. cotton policy. As such, results derived under this assumption approximate an upper bound of price and quantity impacts due to U.S. cotton subsidies. While these models incorporate water subsidies along with price support instruments, we did not include other elements, such as crop insurance. In contrast, in this paper we model the other extreme case—where U.S. cotton farmers respond to the marketing loan rate price rather than the target price in decision making—and include other subsidy instruments previously ignored in our earlier work (e.g., crop insurance). By so doing, we compare the theoretical extremes of the distortionary impacts of U.S. cotton policy. Furthermore, we provide an intermediate scenario where producers respond to price guarantees above the loan rate. This is important because there appears to be little agreement as to producer behavior regarding the response to support prices. Do producers respond to the target price, the loan rate, or neither? How producers respond clearly affects the degree to which policy is decoupled from production.

Other researchers also have examined the distortionary impacts of cotton subsidies. Poonyth et al., for instance, employ a comparative–static, partial–equilibrium global trade model to focus on the impact that aggregated global cotton subsidies have on world prices, production, trade, and welfare, whereas our model focuses specifically on the impact of removing U.S. cotton subsidies. Another major difference is that their work does not include water subsidies. Sumner and Pan et al. both utilize econometric models, which is very different from the approach used in this paper to estimate how the removal of U.S. cotton subsidies would affect U.S. production quantities and the world price of cotton. They do not include water subsidies in their analyses either. While we recognize that Brazil's WTO case against the United States did not address the impact of water subsidies, input subsidies have in general become a focus of the wider WTO framework for resolving trade disputes. With reference to the cotton case, as this paper clearly shows, if one does not include the impact of water subsidies on cotton production and prices, one underestimates the price impact of U.S. cotton price support programs. Moreover, water subsidies alone can be price and trade distorting even in the absence of price supports (Rossi, Schmitz, and Schmitz).

Price-Based Subsidy Instruments and Crop Insurance

The cotton industry in the United States has a long history of governmental support. Following World War I, cotton farmers attempted self-imposed production controls in order to increase prices and incomes. The inevitable coordination failure of such efforts resulted in calls for legislation that would aid the farm economy, ultimately leading to passage of the Agricultural Marketing Act of 1929 (USDA 1996). In the years that immediately followed, the main policy instrument used to support domestic prices and farm incomes were production quotas, which reduced production rather than creating incentives to produce. Marketing loans for cotton farmers were then introduced in the late 1930s and opened the door to the price-support subsidy regime that, although often modified over the years, has subsequently persisted to the present (USDA 1996). The following provides a brief description of the different types of price-based subsidies that currently benefit U.S. cotton producers: direct payments, marketing loans, counter-cyclical payments, and Step 2 payments. Westcott, Young, and Price provide the basis for the following summary of direct payments, marketing loans, and counter-cyclical payments. Beach et al. and Sumner provide information on Step 2 payments.

Direct payments (DPs) under the 2002 Farm Security and Rural Investment (FSRI) Act are made to eligible producers each year, and are based on historical acreage and historical yields. DPs are similar to the production flexibility payments (PFCs) of the

1996 Federal Agriculture Improvement and Reform (FAIR) Act, but differ in that the per-unit payment rate is fixed for the five-year life of the Act (i.e., 2002–2007). Previously, PFCs operated under a fixed total expenditure per year, with the annual per-unit payment rate based on commodity-specific parameters.

The marketing assistance loan (MAL) program of the 2002 FSRI Act continues a long tradition of government loans to producers covering a multiplicity of agricultural commodities. By pledging their crop as collateral, MALs allow producers to secure significant amounts of government benefits, while at the same time giving them several favorable options to repay the loan. These options include repaying the loan at the loan rate plus interest; repaying the loan at a lower rate (if applicable); or forfeiture of the crop, if desired, to the government at the time of the loan maturity. MALs are calculated as the difference between the loan rate and the world price, multiplied by the output quantity. Thus, they are widely considered to be a coupled subsidy as they are directly tied to production levels (Sumner).

Counter-cyclical payments (CCPs) were introduced under the 2002 FSRI Act, and rely upon a "target price" (P_t). The CCP is activated whenever the market price is below this predetermined level. CCPs are based on historical acreage and historical yields and, as such, are generally regarded as decoupled (e.g., Gardner), although there is considerable debate over this issue (Anton and Le Mouel; Lin and Dismukes). This aspect of U.S. cotton policy has no official antecedent in the 1996 FAIR Act, but replaces the impromptu subsidy payments (known as "Market Loss Assistance" payments) that were made to farmers during the years 1998–2001, when several commodity prices crashed. Calculation of the CCP rate is dependent upon the DP rate (P_d), and the world price (P_w) in relation to the loan rate (P_l). If $P_w > P_l$, then the CCP rate equals $P_t - P_d - P_w$. On the other hand, if $P_w < P_l$, then the loan rate is binding and the CCP rate is equivalent to $P_t - P_d - P_l$. Once the CCP rate is determined, calculation of the counter-cyclical payments is

$$\begin{aligned}\text{CCP} = &\ (\text{CCP payment rate})\\ &\times (\text{CCP payment yield})\\ &\times [0.85 \times (\text{Base Acres})].\end{aligned}$$

Although the United States terminated Step 2 program payments as of August 1, 2006, in response to Brazil's successful WTO cotton challenge, they were an important component of U.S. cotton policy. While DP, MLA, and CCP subsidies provide direct benefits to producers, the Step 2 program differed in that it was a demand subsidy that *indirectly* benefited producers. Sumner explains how the effects of Step 2 benefits received by U.S. mills and exporters are transmitted through the supply–demand system to subsequently depress world cotton prices. The Step 2 program was based upon an ongoing review of two separate price differentials to determine if payments were to be made (separately) to domestic mills (consumers), domestic marketers, and exporters. If the U.S. price of cotton exceeded the A Index (world price) by 1.25 cents per pound for four consecutive weeks, and if the adjusted world price (AWP) did not exceed 134% of the loan rate, then Step 2 payments were made to the eligible recipients defined above. The payment rate was equivalent to the difference between the U.S. price and the A Index, minus 1.25 cents per pound (Beach et al.).

In addition to benefiting from price supports, whether directly or indirectly, U.S. cotton producers also receive subsidized crop insurance. Almost all cotton growers participate in the crop insurance program because, according to Sumner, these subsidies are " . . . among the largest available for any crop" (2003, p. 22). Crop insurance subsidies operate in two ways: a direct subsidy on the premiums paid for crop insurance, and subsidy payments made on losses beyond what the premiums cover. In his study, Sumner combined the two and calculated a per-acre–planted national average cotton crop insurance subsidy, and discusses how the crop insurance subsidy effectively increases net revenue per acre planted, and thus has the same effect on production as does a pure production subsidy. Therefore, we incorporate this subsidy into our analysis by calculating a per bale dollar estimate of crop insurance (based upon Sumner's per acre estimate), and add it to the per bale value of the water subsidy.

Input Subsidies and Multiplicative Effects

An input subsidy, acting in conjunction with a price-support mechanism (e.g., the marketing loan rate price), will theoretically distort prices and quantities in a multiplicative manner (Rossi, Schmitz, and Schmitz). This was also found to be the case empirically, even though: (1) water subsidies for cotton are likely important only in Arizona and California, and (2) water subsidies are not a direct policy instrument in terms of federal agricultural policy and payments.[1] Indeed, the history of federal irrigation projects precedes agricultural price–support programs and can be considered more of a traditional subsidy[2] (i.e., producers buy water below the true economic cost) than cash payments and/or loans made to farmers when prices are low. Thus a water subsidy is hidden in the sense that money is not *explicitly received*, but rather the cost of production is lowered for each farm.

Regardless of the specific details that define the transaction of water subsidies in practice, it remains necessary to account for their multiplicative impact in the presence of price supports—if, of course, the subsidy itself is large enough to cause an appreciable shift of the supply curve. Accounting for the value of a water subsidy can be difficult, and several prices can be used to estimate the "true" cost of irrigation water [Environmental Working Group (EWG)]. As mentioned previously, studies by Sumner and Poonyth et al. ignored the water subsidy, presumably because they assumed that its value, its relative spatial coverage (i.e., Arizona and California), or both, was small enough to not affect the sector as a whole. We believe that water subsidies are theoretically important, and thus the model presented later in this paper has explicitly accounted for them. Appendix A provides a brief overview of the data we used to derive our estimate of the water subsidy, and the specific calculation employed.

We now show how the combination of an input subsidy and a price-support instrument has multiplicative price impacts (Rossi, Schmitz, and Schmitz). The following example assumes that a water subsidy lowers the cost of production and induces a downward shift of the supply curve, which in turn causes the multiplicative effects of the two subsidy instruments (i.e., water subsidy and price support) to be greater than a mere summation of the individual effects. Figure 1 shows that the production quantity q^* is established where a given support price (P_s) intersects the water-subsidized supply curve (S') at point a instead of at point i, where it would otherwise be if only a price-support subsidy was in effect. The addition of the water subsidy to the price-support subsidy must necessarily increase q_0 to q^*, given that both types of subsidies are binding simultaneously. In addition to the increased output, there is a decrease in the resulting price necessary to clear the world cotton market, P_w. For example, under a price-support subsidy alone, the market-clearing equilibrium shifts from point e (i.e., no subsidies) to point h; while for a water subsidy alone, the shift from point e is to point k. However, with both subsidies in place, the market-equilibrating shift is from point e to point b. Although the actual magnitude of these shifts is strictly an empirical matter [e.g., it cannot be determined *a priori* whether $(e - k) > (e - h)$, or whether $(e - h) > (e - k)$], it is absolutely clear that $(e - b)$ is greater than either differential individually. Indeed, the main result of Rossi,

[1] Irrigation subsidies are separate from the federal agricultural policy that is enacted every five years. The U.S. Bureau of Reclamation is responsible for supplying irrigation water to farmers, and for setting the purchase price. In addition, water may be subsidized through state programs such as California's State Water Project (EWG).

[2] "A water subsidy is simply the difference between what a contractor is paying for water and how much this water is actually worth" (EWG).

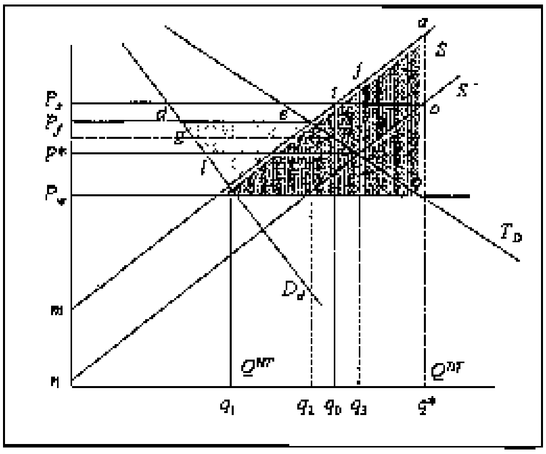

Figure 1. Multiplicative Effects of Water Subsidy and Price Supports Source: Rossi, Schmitz, and Schmitz (2005)

Schmitz, and Schmitz was to empirically prove that $(e - b)$ must be greater than $[(e - h) + (e - k)]$. They therefore referred to Figure 1 as the "multiplicative effects" (ME) model.

Producer Price Expectations

Recent work focusing on agricultural policy has dealt with the issue of whether or not farm-level production decisions are truly decoupled from the agricultural subsidies that the U.S. government provides to farmers. For example, Anton and Le Mouel and Lin and Dismukes investigate how both production incentives, and impacts on production, are created by counter-cyclical payments. Both studies found evidence to call into question the "decoupled" status of the CCP program. Anton and Le Mouel indicate that the CCP program induces production incentives when risk is taken into consideration, while Lin and Dismukes suggest that income and wealth effects induced by CCPs lead to inter-temporal production impacts, in addition to the "modest" short-run impacts they observe. Similarly, Goodwin and Mishra explain that imperfect capital markets and risk-changing wealth effects offer two ways in which DPs could cause production to expand. They use data from 2002 and 2003 to examine the acreage decisions of Corn Belt producers, and find "modest" evidence that DPs influence such decisions.

Given this backdrop, an important consideration affecting the price, quantity, and welfare impacts of U.S. cotton policy is how, and to what extent, are farm payments linked to production. This can perhaps be framed best with the following questions: What price do producers use when determining their production levels and are counter-cyclical payments really decoupled from production? The answer to the first question has a direct bearing on how the theoretical model is depicted, and how the model is subsequently specified with actual data. If producers do respond to support prices, some economists argue that they likely do so at prices slightly above the loan rate (Gardner; Goodwin, Mishra, and Ortalo-Magne). For example, cotton producers could have reasonably expected to receive 9% more than the loan rate, according to calculations made by Gardner based on data for 2000.

The answer to the second question also has an influence on how the model is specified. The work of Anton and Le Mouel and Lin and Dismukes suggests that CCPs may be at least partially coupled. If so, then producers must definitely be setting their supply response somewhere above the loan rate. Nevertheless, our aim is to provide results that define both the upper and lower boundaries of price impacts caused by U.S. cotton policy, as represented by the coupled and decoupled positions (along the support price continuum) that producers respond to in our model.

As shown in Figure 2, the key difference between the loan-rate and target-price scenarios is the selection of the price-support subsidy rate when deriving the supply curve, for a given price elasticity of supply for U.S. cotton and a given production quantity. The nature and position of the supply curve depends on the level of support received by farmers that is directly tied to production—whether at the net target price, to select one extreme position, or at the loan rate. In Figure 2, assume that the actual level of U.S. cotton production q^* corresponds to point z, where the loan rate price P_l intersects the subsidized supply curve

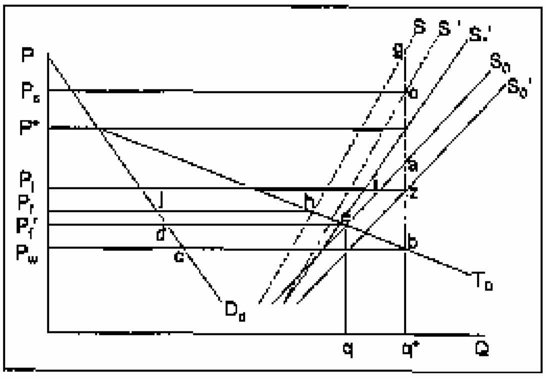

Figure 2. Policy Instruments and the Degree of Decoupling

S'_0. This implies that the loan rate is the price-response mechanism that defines how the supply curve(s) are set. In contrast, the dashed lines in Figure 2 represent "target-linked" supply curves (S and S_0), which are based on the premise that q^* is set at point o using the net target price P_s instead of P_l. The net target price is less than the target price, and is based on the DP rate and a production-adjusted CCP rate added to P_l.[3]

Thus, for a given export demand elasticity (Exd), a given a specific domestic supply–price elasticity (Es) and production point (q^*), we illustrate a model in which two plausible extreme specifications are represented. One, which we refer to as the *target-linked* specification, is based on using the net target price (P_s) to derive the intercept and slope of the subsidized supply curve S'. The other specification, which we refer to as *loan-linked*, relies upon the loan rate (P_l) to derive the intercept and slope of the subsidized supply curve S_0'. The effect of using the loan rate rather than the net target price causes the subsidized supply curve to change from S' to S_0' by shifting downward and rotating clockwise. Essentially, the initial free-trade equilibrium price P_f, derived from the intersection of the target-linked unsubsidized supply curve S and the total demand curve T_D, moves downward along the total demand curve to establish a smaller free-trade price P_f' and smaller free-trade quantity q along the loan-linked unsubsidized supply curve S_0.

Note that all references to "free trade" prices and quantities in this paper are made with the understanding that such theoretical prices and quantities are calculated given the absence of U.S. cotton policy distortions. We do not account for distortions caused by the cotton policies of other nations, and acknowledge that our 'free trade' prices and quantities are affected by distortions caused by countries other than the United States.

This theoretical analysis shows that there can be a significant difference in the impact of policy depending on which assumption is made concerning producer supply response. As mentioned previously, marketing loan payments are widely regarded as coupled—and Figure 2 clearly exhibits this, as S_0' at point z corresponds to the assumption that producers are basing their production decision on the loan rate. If, on the other hand, production decisions are actually based on the net target price, then this would essentially quell the debate as to whether DPs and CCPs are truly "decoupled" or not—regardless of the fact that they are calculated at 85% of base acres. As producers can update their base acres under the 2002 FSRI (Westcott, Young, and Price), an incentive exists for them to maintain production levels—and perhaps even increase them over time (Goodwin and Mishra). Indeed, Sumner (p. 21) states that the anticipation by producers of frequent base-acre updating means that CCPs " . . . are

[3] We use "net target price" to indicate the support price P_s calculated to model coupled DPs and CCPs (Figure 2). It is composed of the DP rate, a production-adjusted CCP rate, and the loan rate. In order for the model to correctly convey the effect of coupled subsidies, it is necessary to represent CCPs and marketing loan payments as applying to all production units. Because not all production units in a given year are eligible for CCPs, the CCP rate was recalculated (i.e., adjusted downward) so that a "net" or "effective" CCP rate could be applied to the actual production quantity for that year. For example, using USDA data we estimate that approximately 12.05 million bales are eligible for CCPs; and in 2002–2003, the CCP rate equaled \$65.90/bale. Thus, CCPs for that year were estimated at \$794.1 million; dividing by 2002–2003 production (17.21 million bales) results in a net CCP rate of \$46.15/bale (9.61 cents per lb.). A similar procedure is used for deriving the net loan payment rate discussed in Footnotes 7 and 10.

almost fully tied to production, although operating with a lag."

However, the target-linked specification in our model framework clearly represents an extreme coupling scenario. What happens, for example, if the degree of coupling is lessened by removing DPs from the coupled model? This case also can be depicted in Figure 2, where the corresponding price and supply curve is now given by P^* and S'_{*}. The price chosen by producers is now above the loan rate and below the net target price. One can discuss additional policy instruments within the context of Figure 2. This model is flexible because it allows one to determine the impact of either an individual or a group of policy instruments. The results presented below are given for specific crop years covering the period 1999–2000 to 2003–2004, and therefore the given supply parameters vary by year.

Data and Methods

The analytical time period of this study covers the crop years 1999–2000 to 2003–2004. Production, export, price, and price-support subsidy rate data used in the analyses are presented in Appendix B, and are derived from the United States Department of Agriculture, Economic Research Service (USDA/ERS 2006). Demand was calculated from the USDA data.[4] As data on the CCP target price did not exist prior to 2002–2003, it was necessary to use estimates for our simulations in these years. Thus, the CCP target prices used for the years from 1999 to 2001 were estimated based on the so-called Market Loss Assistance payments made in each of those years. Both the CCP rate and loan payment rate were appropriately scaled downward in order to derive net or "effective" (i.e., production-adjusted) rates that can be applied to all production units [see Footnote 3 for more detail].

Data on Step 2 rates were taken from Sumner, as was his estimate of the national average crop insurance rate of $19 per acre of planted cotton. We calculated a bales-per-acre conversion rate using national production and planting data from the USDA, and applied these to Sumner's estimate. The *per bale* value of the crop insurance subsidy equals $15.55 for 1999–2003. (All other prices were also converted to U.S. dollars per bale of cotton for each analytical simulation.) The water subsidy value was calculated from data obtained from the Environmental Working Group, the California Department of Water Resources (CDWR), and USDA/ERS (2006). EWG provided estimates of the cost of irrigation water supplied by the U.S. Bureau of Reclamation to farmers in California in 2002. CDWR provided an application rate of water used in cotton cultivation in California; this value is for 2001, as 2002 data were not available. Cotton harvest and production data from USDA were used to calculate a spatial-volume conversion rate (in bales per acre) for 2001, because the data for 2002 were also incomplete. Additional detail, including the derivation of the water subsidy, is presented in Appendix A.

For the initial set of simulations, Beach et al. provide estimates of demand and supply elasticities for the domestic U.S. cotton market: Edd = −0.413 is the domestic demand elasticity utilized, while Es = 0.498 is the domestic supply elasticity. These elasticities were chosen for two reasons: they are recent compared to other estimates found in the literature; and, according to the authors, fall within the ranges of previous estimates.[5] Beach et al. find their estimated export demand elasticity (−0.7) to be on the low end of the range of export demand elasticities found in the literature; therefore, we use the

[4] For the purposes of this paper, U.S. domestic demand for cotton is assumed to be equal to U.S. production less exports. Thus, beginning and ending stocks of cotton are not included in these analyses. Export demand is simply the excess demand for U.S. cotton given the world price, and corresponds to the amount of U.S. cotton exports officially reported by the USDA/ERS. The horizontal addition of these separate sources of demand results in a total demand curve facing U.S. cotton farmers.

[5] See Table 3.3 "Elasticity estimates for cotton" in Karp et al.

reasonable export elasticity estimate of Exd = −1.[6]

However, because there are uncertainties with regard to any elasticity estimates utilized in empirical modeling, and because the export demand elasticity is rather old, alternative simulations are made using a different set of elasticities. The alternate supply elasticity (Es = 0.80) is taken from Poonyth et al., while Sumner provides both of the alternate domestic and export demand elasticities. As Sumner offers two estimates for each elasticity type, depending upon the year, we have averaged these elasticity estimates in order to simulate the average impacts of U.S. cotton subsidies for the period 1999–2003. These estimates are Edd = −0.215 for the domestic demand elasticity, and Exd = −3.304 for the export demand elasticity.

The model was constructed using Microsoft Excel, with the domestic demand and supply curves calculated from data presented in Table B1 in the Appendix. Theoretically, input subsidies simply shift the supply curve downwards and to the right; but constructing the theoretical model from actual data necessitates that the *subsidized* supply curve be derived before the undistorted supply curve can be obtained. This is because the input-subsidized supply of U.S. cotton is what is observed in terms of actual production and export quantities. Therefore, for a given crop year the subsidized supply function was derived from the U.S. cotton production quantity, an estimate of domestic supply elasticity, and the net target price (P_t), for example.[7] The marketing loan rate price (P_l) and the adjusted net target price (P^*) are used to set subsidized supply curves in subsequent models.

As the actual subsidized supply curve is fixed at a specific price and quantity for an empirical simulation, the unsubsidized supply curve is subsequently obtained by adding the $/bale estimate of the cost of input subsidy (i.e., water subsidy + crop insurance subsidy) to the subsidized supply curve. Calculation of the unsubsidized curve is necessary to make comparisons with the scenario where U.S. cotton subsidies are removed. For example, to obtain a "free trade" price (P_f') for the loan-linked model in Figure 2, we substitute the unsubsidized supply function (S_0) into the total demand function T_D. This price can then be substituted back into the supply function to obtain the quantity of cotton produced (q) if the market was free of distortions caused by subsidies to U.S. cotton farmers.

Simulation Results

Results from the initial Target-linked Model are presented in Table 1, and correspond to simulations run for each of the five years beginning with the year 1999–2000. Again, this model specification assumes that both DPs and CCPs positively influence the production decisions made by farmers, and correspond to the net target price as opposed to the loan rate.[8] Table 1 displays the price, production, and export differences between the world price free of U.S. cotton policy effects (i.e., "free trade" price P_f) and the base-case scenario (i.e., world price P_w) for each

[6] As cited in Karp et al.; this estimate itself appears to be on the low end of the long-run export demand elasticity range.

[7] The Target-linked Model is specified by adding the direct payment rate and net CCP rate to the given marketing loan rate price (P_l), establishing a net target price (P_t) that links the subsidized supply curve S' to point o in Figure 2. In addition, the net loan payment rate and the Step 2 payment rate are subtracted from P_l to establish a simulated world price. Together, these four components equal the price wedge calculated for each particular year of analysis, and simulated by the Target-linked Model.

[8] The net target price is based, in part, on the net CCP rate (see Footnote 3), which itself is based on the 2002 FSRI target price. As there was no official target price in 1999–2000 and 2001–2002, we estimate what the target price would have been, based upon Market Loss Assistance (MLA) subsidy payments made to producers during this period, estimated eligible production quantity for 2002, and the loan rate and DP rate. The ad-hoc MLA program later became institutionalized as the CCP program under the 2002 FSRI Act (Anton and Le Mouel); thus we wish to approximate its impact in 1999–2001 by treating it exactly like a CCP.

Table 1. Cotton Target-linked Basic Model (Es = 0.498, Edd = −0.413, and Exd = −1.00)

Year	Free Trade Price	FT Price Difference	FT Price Difference	Free Trade Production	FT Production Difference	FT Production Difference	Free Trade Exports	FT Export Difference	FT Export Difference
	P_f	$P_f - P_w$	$P_f - P_w$	q_f^*	$q_f^* - q^*$	$q_f^* - q^*$	q_{xf}	$q_{xf} - q_x$	$q_{xf} - q_x$
	$/Bale	$/Bale	Percentage	Million Bales	Million Bales	Percentage	Million Bales	Million Bales	Percentage
1999–2000	$231.76	$52.55	29.3%	13.75	−3.22	−19.0%	4.77	−1.98	−29.3%
2000–2001	$271.09	$44.97	19.9%	14.99	−2.20	−12.8%	5.40	−1.34	−19.9%
2001–2002	$246.90	$42.35	20.7%	17.23	−3.07	−15.1%	8.72	−2.28	−20.7%
2002–2003	$266.83	$39.64	17.4%	14.75	−2.46	−14.3%	9.82	−2.08	−17.4%
2003–2004	$273.05	$36.08	15.2%	15.85	−2.38	−13.1%	11.70	−2.10	−15.2%
Average	$257.92	$43.12	20.5%	15.31	−2.67	−14.8%	8.08	−1.95	−20.5%

year.[9] In addition, the average impacts for the crop years 1999–2000 to 2003–2004 are shown. For example, the average free trade price would equal $257.92 in the absence of U.S. cotton subsidies. This means that there is a 20.5% difference between this price and the simulated world price: $P_f - P_w =$ $43.12 per bale. Table 1 also indicates that average U.S. cotton production and U.S. cotton exports would decline by 2.67 million and 1.95 million bales per year, respectively, if U.S. cotton subsidies were removed.

The main purpose of this paper is to contrast the extreme case of a target-linked scenario, as represented above, with a model based upon the assumption that farmers respond to the loan rate. The latter specification represents the lower bound of policy distortion where DPs and CCPs are fully decoupled from production, while loan-based payments are fully coupled. Table 2 presents the results of simulations from the Loan-linked Model.[10] Since the loan rate is not binding for much of 2003–2004, we use the USDA's adjusted world price (AWP) to set the subsidized supply curve for this particular crop year. As Table 2 indicates, the Loan-linked Model specification calculates an average price differential (free trade price minus world price) equal to $P_f - P_w =$ $25.66 (12.4%); which is more than $17 per bale less than the average differential of the Target-linked Model. Table 2 also shows that, as expected, the change in free-trade production

[9] Again, all references to "free trade" prices and quantities in this paper are made with the understanding that such theoretical prices and quantities are calculated given the absence of U.S. cotton policy distortions. Moreover, we do not account for distortions caused by the cotton policies of other nations.

[10] The Loan-linked Model is specified by subtracting the net loan payment rate and the Step 2 payment rate from the given marketing loan rate (P_l), in order to establish a simulated world price. Together, these two components equal the price wedge calculated for each particular year of analysis; in this case the subsidized supply curve S_0 is set at point z in Figure 2. For 2003–2004, the Loan-linked Model is specified by subtracting the Step 2 payment rate from the adjusted world price (AWP), in order to establish a simulated world price

Table 2. Cotton Loan-linked Basic Model ($Es = 0.498$, $Edd = -0.413$, and $Exd = -1.00$)

Year	Free Trade Price	FT Price Difference	FT Price Difference	Free Trade Production	FT Production Difference	FT Production Difference	Free Trade Exports	FT Export Difference	FT Export Difference
	P_f	$P_f - P_w$	$P_f - P_w$	q_f^*	$q_f^* - q^*$	$q_f^* - q^*$	q_{xf}	$q_{xf} - q_x$	$q_{xf} - q_x$
	$/Bale	$/Bale	Percentage	Million Bales	Million Bales	Percentage	Million Bales	Million Bales	Percentage
1999–2000	$215.96	$36.75	20.5%	14.72	−2.25	−13.3%	5.37	−1.38	−20.5%
2000–2001	$249.31	$23.19	10.3%	16.05	−1.13	−6.6%	6.05	−0.69	−10.3%
2001–2002	$232.43	$27.89	13.6%	18.28	−2.02	−10.0%	9.50	−1.50	−13.6%
2002–2003	$246.97	$19.78	8.7%	15.98	−1.23	−7.1%	10.86	−1.04	−8.7%
2003–2004[a]	$257.66	$20.69	8.7%	16.86	−1.36	−7.5%	12.60	−1.20	−8.7%
Average	$240.47	$25.66	12.4%	16.38	−1.60	−8.9%	8.87	−1.16	−12.4%

[a] The loan rate was binding for only part of the year, resulting in the average annual loan rate being above the world price. Thus, the subsidized supply curve is set using the Adjusted World Price (AWP) obtained from USDA data.

(1.60 Mb) and export (1.16 Mb) quantities are less than in the target-linked simulations.

Table 3 displays the descriptive statistics of these two models, as well as those of a third model specification referred to as the "Coupled CCP Model". This specification represents an intermediate position of the subsidized supply curve in the interval between the loan rate and the net target price. It differs from the target-linked specification by directly adding only the effective CCP rate to P_l, in order to arrive at P^*, the adjusted net target rate (Figure 2). This specification results in simulated free trade prices that are roughly halfway between the free trade prices obtained from the other two models. The average free trade prices from Table 3 confirm this (due to space limitations, we do not show each individual year).

We also modified the basic parameter specification of our models described above by incorporating an alternative set of elasticity estimates. For this "Alternative (PSS)" Model, we utilize elasticity estimates employed by Poonyth et al. (2004) and Sumner (2003) in their studies.[11] Table 4 presents the average impacts on world price simulated from this alternative model, and offers a comparison with the results from the previous simulations, including Sumner's price impact as well.[12] Again, the comparison period covers the crop years 1999–2000 through 2003–2004. The alternative simulations have somewhat less of an effect on the free trade–world price differential, although

[11] Sumner provides domestic demand and export elasticity estimates for the years 2000 and 2003. For the Alternative (PSS) Model, we have averaged these elasticity estimates in order to simulate the average impacts of U.S. cotton subsidies for the period 1999–2003.

[12] Model results of Pan et al. suggest that simulated world cotton price increases would be very low, ranging from 0.45% to 2.14% over a 10-year period (2004–2013). Because of the time period, a direct comparison cannot be made with the results in Table 4. However, their results may well be extreme, and may suggest a model specification based on the loan rate (i.e., only loan payments are coupled). Moreover, the base world prices they project are relatively high, which implies that loan payments would be relatively low.

Table 3. Comparison of the Basic Models for the Crop Years 1999–2000 to 2003–2004

Model	Free Trade Price P_f $/Bale	FT Price Difference $P_f - P_w$ $/Bale	FT Price Difference $P_f - P_w$ Percentage	Free Trade Production q_f^* Million Bales	FT Production Difference $q_f^* - q^*$ Million Bales	FT Production Difference $q_f^* - q^*$ Percentage	Free Trade Exports q_{xf} Million Bales	FT Export Difference $q_{xf} - q_x$ Million Bales	FT Export Difference $q_{xf} - q_x$ Percentage
Target-linked									
Average	$257.92	$43.12	20.5%	15.31	−2.67	−14.8%	8.08	−1.95	−20.5%
SD	$17.94	$6.22	5.4%	1.31	0.45	2.5%	2.94	0.36	5.4%
CV	7.0%	14.4%	26.2%	9%	−17%	−17%	36%	−18%	−26%
Loan-linked[a]									
Average	$240.47	$25.66	12.4%	16.38	−1.60	−8.9%	8.87	−1.16	−12.4%
SD	$16.44	$6.95	5.0%	1.31	0.50	2.8%	3.10	0.32	5.0%
CV	6.8%	27.1%	40.2%	8%	−31%	−31%	35%	−27%	−40%
Coupled CCP									
Average	$250.26	$35.45	16.9%	15.78	−2.20	−12.2%	8.43	−1.61	−16.9%
SD	$17.23	$6.26	5.1%	1.32	0.47	2.6%	3.01	0.33	5.1%
CV	6.9%	17.7%	30.2%	8%	−21%	−21%	36%	−21%	−30%

[a] The loan rate was binding for only part of the 2003–2004 crop year, resulting in the average annual loan rate being above the world price of cotton. Thus, for crop year 2003–2004, the subsidized supply curve is set using the Adjusted World Price (AWP) obtained from USDA data.

Table 4. Comparison of Models for the Crop Years 1999–2000 to 2003–2004

	Average Free Trade Price	Average Free Trade Price Difference	Average Free Trade Price Difference	SD Free Trade Price Difference	CV Free Trade Price Difference
	P_f	$P_f - P_w$	$P_f - P_w$	$P_f - P_w$	$P_f - P_w$
Specification	$/Bale	$/Bale	Percentage	$/Bale	Percentage
Basic model					
Target-linked	$257.92	$43.12	20.5%	$6.22	14.4%
Loan-linked	$240.47	$25.66	12.4%	$6.95	27.1%
Coupled CCP	$250.26	$35.45	16.9%	$6.26	17.7%
Alternative (PSS)[a]					
Target-linked	$245.87	$31.06	14.9%	$7.66	24.7%
Loan-linked	$233.76	$18.95	9.2%	$6.64	35.0%
Coupled CCP	$240.60	$25.79	12.4%	$6.93	26.9%
Sumner	$274.37	$30.88	12.5%	$10.72	34.7%

[a] (Es = 0.800, Edd = −0.215, and Exd = −3.304)

the relative variance is higher as observed in the increased coefficient of variation for each specification type (e.g., target-linked, loan-linked). This is so even though the Alternative (PSS) Model employs a larger supply elasticity; the much greater increase in the export elasticity effectively negates the positive effect of these factors, and actually reduces the price distortion as compared to the initial models.

Conclusion

While this paper places focus on the impact of U.S. cotton subsidies, it has applicability to other major U.S. crops covered by U.S. farm subsidy programs. The effects of U.S. agricultural policy are increasingly being scrutinized, especially in view of the successful Brazilian challenge to U.S. cotton subsidies in the WTO. Our results show that the impact of U.S. cotton subsidies can be significant, as also found to be the case in the Brazilian challenge (Powell and Schmitz). The significant price suppression terminology used in the WTO ruling unfortunately does not provide guidance as to where producers respond along the price continuum in our model. Moreover, the findings in the WTO rulings do not give an empirical gauge as to the degree of decoupling. For example, the average negative price impact of 12.4% obtained from our "Loan-linked Model" may be considered significant despite the low degree of decoupling in this specification.

Alternatively, our fully coupled "Target-linked Model" shows an average negative price impact of 20.5%. The degree to which cotton subsidies are coupled to production is still open to debate, as is true for other commodities supported by U.S. price support programs. In this paper, we present the effects of both a target-linked and a loan-linked specification. As each specification represents an extreme case of the coupling–decoupling debate, we also offer an intermediate case in which CCPs are fully coupled while direct payments are not. The average negative price impact for this intermediate scenario ("Coupled CCP Model") is 16.9%. Within our flexible framework, one can easily model the impact of U.S. cotton subsidies where only a percentage of CCPs are coupled to production.

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Appendix A

As an estimate of the dollar value (per bale of cotton) of the water subsidy was necessary to complete the analysis described in this paper, we relied upon estimated irrigation water costs, in acre-feet, as calculated by the Environmental Working Group (EWG). Below we provide a very brief summary of their estimates, but refer the interested reader to the website listed in the reference section for more detail on their methodology and discussion

Farms in the Central Valley of California receive subsidized irrigation water from the U.S. Bureau of Reclamation (REC). For the year 2002, there are three possible estimates (in dollars per acre-feet) of the "true" cost of Central Valley Project (CVP) irrigation water. We refer to these *"true cost rates"* as the CVP rates. These rates were obtained from the EWG report *California Water Subsidies* (EWG), as was the estimated average price paid (*APP*) by irrigators for CVP water in 2002. To obtain specific values of the CVP water subsidy, one must subtract the APP from estimates of the CVP rate. The lowest *true cost rate* estimated by EWG is referred to as the *"full cost" rate*, which they explain actually understates the true value of the CVP water. "Despite its name, the Bureau's 'full cost' rate is widely recognized as being too low to be considered a good estimate for the true cost of CVP irrigation water . . . " (EWG).

The second *true cost rate* obtained from the EWG report is known as the *EWA rate*, and it is three times higher than the REC "full cost" rate. EWA is an acronym for the Environmental Water Account, which is a state program that buys water from willing sellers in the CVP and/or the State Water Project (SWP) for environmental applications. For example, various uses include the improvement of water quality in specific stretches of a river, or improvements to water quantity in order to aid threatened or endangered wildlife. As such, the *EWA rate* is essentially a quasi-market price for water. Moreover it actually lends itself, conceptually, for use as a subsidy: "As the EWA is a publicly funded entity, the government is essentially selling CVP water to farmers at very low prices and then buying it back later at much higher rates to replace water that was in the river in the first place" (EWG). Therefore, we employ the *EWA rate* ($129.48 per acre-feet) when deriving our per-bale dollar-value estimate of subsidized water.

A third *true cost rate* calculated by EWG is known as the *"replacement water rate"*. It is 32% greater than the EWA rate (the highest estimate of the cost of CVP water that they report). The *replacement water rate* represents the cost of providing "new" or additional water supplies to the CVP, as based upon the projected costs of building a new dam in the San Joaquin basin. Although EWG claims that the estimate they calculate is rather conservative, it nevertheless provides " . . . a lower bound on what a new supply of irrigation water might cost" (EWG).

Even though a theoretical argument can be made for the replacement water rate being a good approximation of the "true" cost of CVP irrigation water, in this study we have chosen to employ the EWA rate as the basis for our water subsidy. There are four reasons for this choice: (1) the Bureau of Reclamation's "full cost" rate is not a good measure of the true cost of CVP water, (2) the EWA rate is based on an existing "market" for water, (3) the replacement water rate is based upon cost estimates of constructing a new dam at some point in the future, and (4) the EWA rate represents a middle estimate between the "full cost" rate and the replacement water rate.

In order to calculate a water subsidy for use in this paper, several steps were required. The main steps involved were:

1. Obtaining an estimate of the value of subsidized water (*CVP rate − APP*), in $/acre-feet, from EWG.
2. Obtaining an estimate of the application rate of water (*ARW*), in acre-feet/acre, used in cotton cultivation in California.
3. Estimating, in bales/acre, a spatial volume conversion rate (*SVCR*).
4. Calculating, for a five-year period (1999–2003), average Arizona and California cotton production (*ACCP*) as a percentage of total U.S. cotton production.

The calculation of the water subsidy (*WS*) is as follows:

$$WS = [(CVP\ rate - APP) \times (ARW/SVCR)] \times (ACCP)$$

$$WS = [(129.48 - 17.14) \times (3.23/2.832)] \times (0.137)$$

$$WS = \$17.55 \text{ per bale.}$$

Appendix B

U.S. cotton data for 1999–2003 are shown in Appendix Table 1.

Appendix Table 1. U.S. Cotton Data for 1999–2003

	Production	Exports	Target Price	Effective Target Rate[b]	Marketing Loan Rate	Effective LDP Rate[b]	Direct Payment Rate	Step 2 Payment Rate[c]	Input Subsidy[d]
	q^*	q_x	P_t	P_{ec}	P_l	P_{el}	P_d	P_2	IS
Year	Million Bales	Million Bales	Cents per lb.	Cents per lb.	Cents per lb.	Cents per lb.	Cents per lb.	Cents per lb.	$ per Bale
1999–2000	16.968	6.750	69.90[a]	7.53	51.92	6.68	7.37	7.90	33.10
2000–2001	17.188	6.740	69.88[a]	7.43	51.92	1.41	7.37	3.40	33.10
2001–2002	20.303	11.000	68.34[a]	6.35	51.92	6.03	5.72	3.28	33.10
2002–2003	17.209	11.900	72.4	9.61	52.0	2.01	6.67	2.66	33.10
2003–2004	18.255	13.758	72.4	9.08	52.0	0.13	6.67	5.69	33.10
Average	17.98	10.03	70.58	8.00	51.95	3.25	6.76	4.59	33.10
Std. Dev.	1.39	3.17	1.77	1.33	0.04	2.92	0.68	2.18	-

Data source: USDA/ERS (2006), unless otherwise noted.

[a] Estimated target price.

[b] Calculated based on USDA data.

[c] Data obtained from Sumner (2003).

[d] Water subsidy plus crop insurance subsidy; calculated based on various data sources