Trade Effects of U.S. Commodity Programs

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Abstract. *The acreage reduction requirements in the 1986 wheat and corn programs more than offset the subsidy effects of the target price/deficiency payment portion of the programs Target prices and deficiency payments affect world markets much like direct export subsidies, and acreage reduction requirements affect markets like an export tax This article estimates export subsidy and tax equivalents of commodity price and income support programs for wheat and corn The 1986 crop-year programs were equivalent to imposing substantial export taxes, although the level of implicit tax was reduced by about half compared with the 1985 crop-year programs*

Keywords. *Export subsidy, export tax, direct payments, target prices, acreage reduction*

An income supplement program, where the payment is tied closely to the quantity of the commodity produced, increases domestic production because producers respond to the payment rather than to the market price The Food and Consumer Protection Act of 1973 introduced the concept of deficiency payments Rather than setting direct payments equal to a fixed sum as during the sixties, the 1973 Act made payments variable, increasing when prices declined, decreasing when prices rose, and disappearing when prices exceeded established target price levels All farm legislation since 1973 has included a target price/deficiency payment for wheat, feed grains, rice, and cotton

The commodity programs that use target prices and deficiency payments are designed to protect farm income while allowing loan rates to be reduced to market levels However, with a simple world trade model, one can demonstrate that such a program can induce expanded production, leading to a larger excess supply (*6*) [1] Such a program lowers world prices and boosts the market share of the country paying the income subsidy Thus, the payment may be viewed, as it has been by the European Community and Canada, as operating in much the same way as would an export subsidy on the commodity The Ontario Corn Growers Association recently filed a countervailing duty case against corn imports from the United States, charging that the United States was, through its farm support programs, subsidizing exports of corn A country's requirement that acreage be reduced or its imposition of a price-support loan above market-clearing prices affects markets in the same way as would an export tax on the commodity The results of this analysis suggest that, contrary to the Ontario Corn Growers' position, the U S program actually acts as a significant export tax on corn

The U S Government has used direct export subsidies, although the Constitution specifically prohibits direct taxation of exports The use of the terms "subsidy equivalent" or "tax equivalent" in this article should not be confused with these other tools Rather, they are simply the estimates of the subsidy or tax which, if imposed directly, would affect U S exports and excess domestic supply of wheat and corn in the same way

In this article, I estimate the net export subsidy/tax equivalent effects of the total program, including target price/deficiency payment, acreage reduction, and loan rates in effect for the 1986-87 crop year for U S wheat and corn producers I show that the Food Security Act of 1985 influenced the magnitude of the export subsidy/tax equivalents.

Figure 1 shows a two-country, single-commodity model where both countries initially trade in a freely competitive market World market supply equals the excess supply of the exporting country (ES), or total supply (S) less domestic demand (D) (See panel 1) Demand in the world market is determined by the excess demand of the importing country (ED), or importing country domestic demand less importing country domestic supply (See panel 3) Price (P_f) and the quantity traded (X_f) are determined in the world market

The figure also illustrates what occurs if the exporting country (in this case the United States) distorts the free trade equilibrium by establishing a guaranteed mini-

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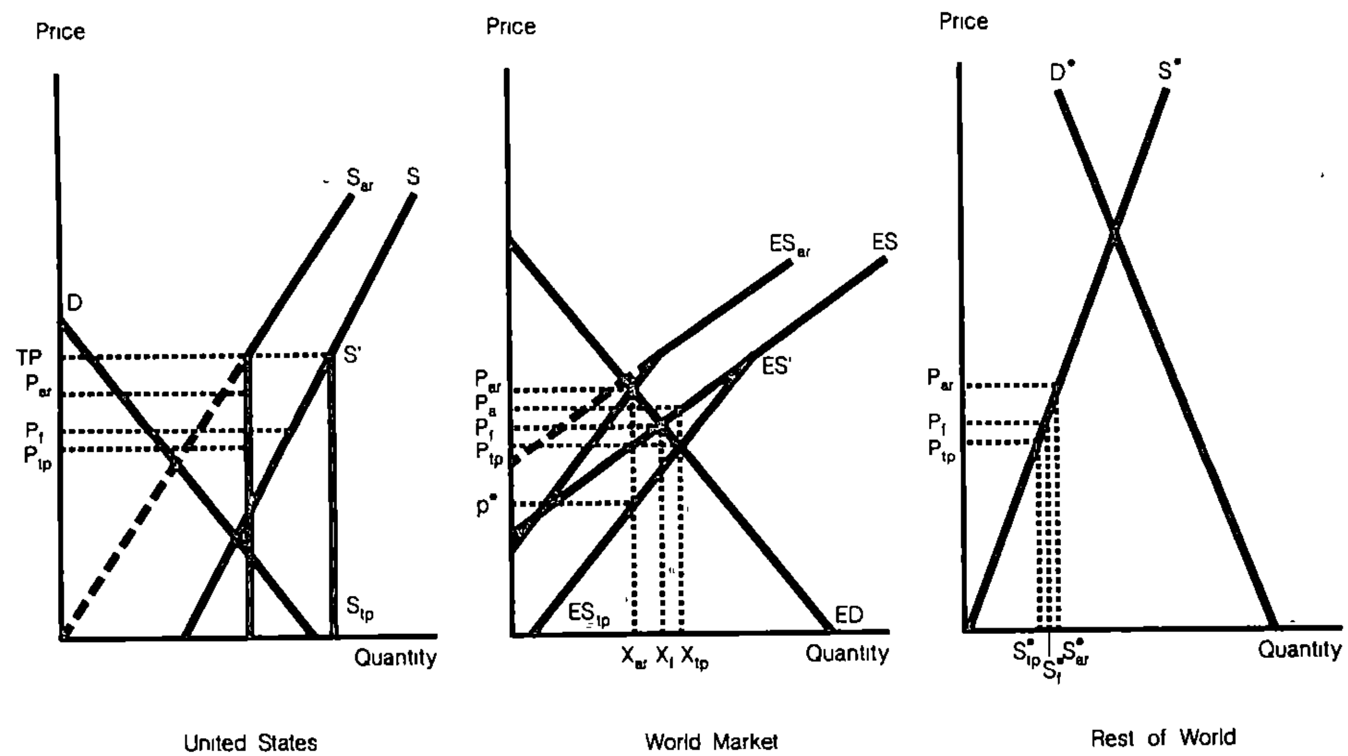
[1] Italicized numbers in parentheses refer to items in the References at the end of this article

Free trade model for a single commodity



mum expected price, that is, a target price (TP). Domestic supply becomes $S_{tp}S'S$, and excess supply in the world market shifts outward to $ES_{tp}ES'ES$, resulting in larger exports (X_{tp}) and a lower world price (P_{tp}) Supply in the rest of the world falls from S_{f*} to S_{tp*}, implying a larger market share for the exporting country. The effect would be the same as if the exporting country paid an export subsidy of $P_a - P_{tp}$ per unit

The analysis of US commodity programs is less straightforward In 7 of 13 years since crop year 1974, corn and wheat producers were required to idle some acreage to be eligible for deficiency payments In all but 1 of those 7 years, wheat farmers received diversion payments for some of the idled acreage, further increasing their incentive to reduce acreage Corn producers received cash or in-kind diversion payments in all but two of the years Such acreage reductions correspondingly reduce supply, which increases price and at least partially offsets the implicit export subsidy

In the figure, panel 1, supply shifts inward to S_{ar}, reflecting the requirement to idle acreage The exact shape of the domestic supply curve in the face of an acreage reduction requirement cannot be determined *a priori* The curve will probably shift less when the expected price is high than when it is low because US programs are voluntary and because a high expected price makes the programs less attractive Excess supply would shift inward to ES_{ar}, and price would rise above the free market price (see figure) Some producers would participate even when the expected price exceeds the target price, perhaps as a form of insurance At high expected prices some, although probably proportionally less, acreage may be idled, suggesting either a nonlinear supply or a kink at or near TP The figure is constructed to show both increasing participation at lower prices and a kink at the target price Paarlberg and others (*6*) construct a similar diagram with a parallel shift in domestic and excess supply, implicitly assuming that expected program returns relative to expected market returns have no bearing on the participation decision, an assumption that makes diagrammatics simpler but that is, in fact, unrealistic and unsupported

The exact effect on production of acreage reduction requirements versus deficiency payments can only be determined empirically Hence, the amount of the shift as illustrated in the figure is arbitrary If the relation ship is nonlinear, or kinked as suggested above, the acreage restriction could shift supply less in the relevant price range, such that the negative production effects of the acreage reduction requirement would be more than offset by the positive effects of the target price/deficiency payment program

Another element of the farm commodity program, the price-support loan, is not illustrated in figure 1 Readers can consult Paarlberg for an illustration of the program including the price-support loan (6)

The Effect of Slippage

One factor that makes the net effect of contemporary programs uncertain is slippage Slippage is apparent when farmers are required to idle a certain percentage of their acreage and when total acreage planted falls by less than idled acreage Slippage is also apparent when production falls by less than the percentage implied by the acreage reduction program

Slippage results from two basic situations First, farmers who participate in the program will generally idle their least productive land Because only land is idled, they are free to increase the use of other inputs on the land remaining in production These forces tend to increase average yields substantially on the land that remains in production Second, farmers who do not participate in the program, or producers with more than one farm who choose not to participate on all their farms, can expect the acreage reduction program to boost prices Hence, with higher expected prices they have an incentive to expand acreage, which at least partially offsets the intent of the acreage-idling requirement

Measuring the Subsidy or Tax Equivalent

The figure also illustrates how one can calculate the implicit export subsidy or tax equivalents of various programs If only a target price is in effect, with no requirement for acreage reduction, the new world market price and quantity are P_{tp} and X_{tp}, respectively To generate an excess supply of X_{tp} without a target price, a price of P_a would be required Hence, the difference between P_a and P_{tp} would be the level of export subsidy required to generate the extra production and to move it onto the world market In effect, we can view the implicit subsidy as the wedge between what the producer receives (P_a) and the importing country pays (P_{tp})

In the figure we also observe that X_{ar} is sold at price P_{ar} when an acreage reduction requirement is in effect That quantity would be produced in a free market at a price of P^*, hence, an export tax equal to ($P_{ar} - P^*$) would be required to yield the market result illustrated Such a tax would be required to reduce both exports and excess supply to X_{ar} Again, the tax can be measured as the wedge between the price the importing country pays (P_{ar}) and the price the producer receives (P^*) In the empirical analysis to follow, the subsidy and tax equivalents of the various programs are calculated in a similar manner I substituted the equilibrium quantity into the estimated "no program" supply curve to determine the corresponding no program price I compared that price with the price resulting from the program under consideration, the difference being either the equivalent export tax or the subsidy generated by the program

Note that the equivalent export tax or subsidy of the program does not equal the smaller price change required just to change exports The export tax or subsidy must be large enough to force the necessary adjustment in excess supply (via production and domestic demand) as well Thus, although in the case of the export subsidy illustrated above, exports rose from X_f to X_{tp}, which could occur if price falls from P_f to P_{tp}, that change alone would not induce production and, hence, excess supply to expand To induce an excess supply of X_{tp}, a price of P_a would have to prevail in the domestic market, hence, the export subsidy equivalent is $P_a - P_{tp}$

Likewise, if an export tax were used to reduce exports to X_{ar}, the tax would need to be large enough to reduce excess supply to that level Although raising the price from P_f to P_{ar} could cut exports to X_{ar}, the price in the domestic market must fall to P^* to restrict excess supply to X_{ar} Hence, the export tax, or wedge between the export price and domestic price, would have to equal $P_{ar} - P^*$

Modeling Production and Slippage

Economists have used several approaches to incorporate the voluntary nature of the U S program into agricultural sector models Houck and Ryan (4), Gallagher and Green (3), and Langley (5) used market and program returns to improve estimates of production response Bancroft (1) developed a model relying on net returns from the program and the market to endogenously predict the level of farmer participation in commodity programs Salathe and others (7) incorporated the latter approach in developing the U S Department of Agriculture's (USDA) Food and Agricultural Policy Simulator (FAPSIM) model of the agricultural sector

FAPSIM's wheat and corn components were used to estimate the program's effects on implicit export subsidies and/or export taxes The acreage response relationships in FAPSIM reflect the relative profitability of participation in Government programs (See the appendix for a more detailed description of the production, yield response, and participation equations contained in FAPSIM) The model also accounts for slippage due to increased nonparticipant planting by incorporating acreage planted by participants as one determinant of nonparticipant plantings Such slippage for wheat is estimated at 0 33 (t = 5 32), that is, for each acre idled by participants, nonparticipants increase planting by a third of an acre Corn acreage slippage is 0 40 (t = 12 09) The model accounts for yield slippage by incorporating acreage planted and program acreage in the yield equation Wheat yield increases by 0 13 (t = 3 53) bushels per acre for each 1 million idled wheat acres Corn yield slippage is 0 47 (t = 3 57) (*2*)

The FAPSIM wheat and corn sector equations, which Gadson and others document (*2*), were extracted and set up as separate models to estimate the production and export subsidy/tax effects of current U S farm programs The base case was the "no program" excess supply and excess demand I estimated the base case excess supply by simulating wheat and corn production and domestic demand for several price levels These results were then used to construct an excess supply curve for wheat and corn Excess supply curves were also generated for the case where production and export subsidy equivalents would be the largest a target price of $4 38 per bushel for wheat and $3 03 per bushel for corn, with no requirement for acreage reduction Finally, I examined two contemporary cases An excess supply curve was generated after I imposed the actual 1985 crop-year programs for wheat and corn, based on the Food and Agriculture Act of 1981 and another program for the actual 1986 crop year programs, based on the Food Security Act of 1985 One can use these two cases to evaluate the effects of the 1985 Act on potential and actual export subsidy/tax equivalents for wheat and corn

The procedure was straightforward I introduced various expected prices into the production side of the models, given the above-mentioned program assumptions For each price a production level was generated For each price a domestic (food, feed, and seed) quantity demanded was also generated which, when subtracted from production, yielded excess supply Government stocks were assumed to be fixed except when the price-support loan was in effect Free stocks were price-responsive, consistent with FAPSIM Excess demand was the export demand contained in the FAPSIM model with all variables except price held constant

Calculating the Subsidy and Tax Equivalents

Table 1 contains the slope and intercept terms for the four linear excess supply curves for wheat representing the actual 1986 crop-year program based on the Food Security Act of 1985, the 1985 crop-year program based on the Food and Agricultural Act of 1981, the "no program" excess supply, and the excess supply that would exist if the program included only a target price of $4 38 per bushel with no requirement for acreage reduction The excess demand curve reported in table 1 is the wheat export demand taken from FAPSIM, with all factors except price held constant Also reported are the prices, quantities, and implicit export subsidies or taxes associated with each program alternative

The "no program" equilibrium price and quantity are $1 51 and 1 31 billion bushels, respectively When one introduces a $4 38 target price without requiring acreage reduction, the equilibrium price falls to $0 65 and the quantity rises to 1 511 billion bushels An equivalent export subsidy of $1 56 per bushel would have to be paid to raise both excess supply and exports to this level It is calculated as follows It takes a domestic price of $2 21 per bushel to generate an excess supply of 1 511 billion bushels and an export price of $0 65 per bushel to sell this quantity to importing countries The difference ($2 21 − $0 65 = $1 56) is the export subsidy necessary to achieve the same results as a target price only program

When the 1985 program is introduced, assuming no minimum loan rate or support price, the price rises to $1 93 per bushel and exports fall to 1 211 billion bushels That program is equivalent to an export tax of $0 78 per bushel The equivalent export tax is computed in the same manner as the export subsidy A domestic price of $1 15 is required to generate an excess supply of 1 211 billion bushels An export price of $1 93 is required to restrict exports to that level The difference ($1 93 − $1 15 = $0 78) is the export tax required to achieve the same results as the 1985 program The 1986 program, based on the Food Security Act of 1985, requires a larger acreage reduction Thus, the export tax equivalent would be even higher, $0 91 per bushel, as it would raise the price to $2 00 and restrict exports to 1 194 billion bushels The effect on production of the conservation reserve, also included in the 1985 Act, was inconsequential for the 1986 wheat and corn crops However, it will become more significant and increase implicit export taxes, other things being equal

The actual 1985 and 1986 crop-year programs for wheat included price-support loan rates above market-clearing levels The 1985 program loan rate was $3 30 per bushel

Table 1—Wheat Estimates of tax and subsidy equivalents

Item	Unit	No program	Target price only	1985 program	1986 program
Agricultural programs					
Target price	Dollars/bushel	—	4 38	4 38	4 38
ARP	Percent	—	—	20	225
PLD	Percent	—	—	10	125
Loan rate	Dollars/bushel	—	—	3 30	2 30
Excess supply equation					
Slope	—	282 905	171 667	327 190	336 119
Intercept	1,000 bushels	884 560	1,399 580	579 631	521 988
Excess demand equation					
Slope	—	-235 000	-235 000	-235 000	-235 000
Intercept	1,000 bushels	1,664 000	1,664 000	1,664 000	1,664 000
World price	Dollars/bushel	1 51	0 65	1 93	2 00
U S exports					
Without loan	1,000 bushels	1,310	1,511	1,211	1,194
With loan	1,000 bushels	—	—	889	1,124
Export subsidy (tax) equivalent					
Without loan	Dollars/bushel	0	1 56	(0 78)	(0 91)
With loan	Dollars/bushel	—	—	(3 28)	(1 46)

ARP = Acreage reduction program
PLD = Paid land diversion
— = Not applicable

At that level exports would be restricted to an estimated 889 million bushels The equivalent export taxes necessary to reduce excess supply and exports to 889 million bushels, if producers faced a "no program" market, would be $3 28 per bushel The 1986 program reduced the loan rate to $2 30 per bushel, after the enactment of the Balanced Budget and Emergency Deficit Control Act of 1985 (Graham, Rudman, Hollings) This loan rate would still set the market price floor, but would allow exports to rise to 1 124 billion bushels Although less than half the 1985 program, the equivalent export tax implied by the 1986 program is $1 46 per bushel

Table 2 contains the slope and intercept terms for the four linear excess supply curves for corn representing the 1986 crop-year program based on the 1985 Act, the 1985 crop-year program based on the 1981 Act, the "no program" excess supply, and the excess supply that would exist if the program included only a target price of $3 03 with no requirement to reduce acreage As with wheat, excess demand is the corn export demand from FAPSIM, with all factors but price held constant Also reported are the prices, quantities, and implicit export subsidies or taxes associated with each program alternative

The "no program" equilibrium price and quantity are $1 47 and 1 788 billion bushels With only a target price and no requirement for acreage reduction, the price falls to $0 75 and exports rise to 2 062 billion bushels An implicit export subsidy of $0 94 would be required to increase excess supply and exports to that level The programs derived from the 1981 and 1985 acts have similar effects except for the loan rates Each required an acreage reduction, however, the 1985 Act and the subsequent Balanced Budget and Emergency Deficit Control Act of 1985 allowed the loan rate to be reduced from $2 55 to $1 84 The 1985 program based on the 1981 Act resulted in a price of $1 85 per bushel and exports of 1 645 billion bushels, assuming no price-support loan The equivalent export tax required to reduce excess supply and exports to that level would be $0 49 per bushel However, with a $2 55 loan rate, exports would fall to only 1 378 billion bushels, implying an export tax of $1 40 For the 1986 program, based on the 1985 Act, however, the price would be $1 94 per bushel and exports would be 1 609 billion bushels An implicit export tax of $0 61 per bushel would be necessary to reduce excess supply and exports to that level Because the loan rate was below the market price resulting from the acreage reduction, it would not add more to the implicit export tax

Table 2—Corn· Estimates of tax and subsidy equivalents

Item	Unit	No program	Target price only	1985 program	1986 program
Agricultural programs					
Target price	Dollars/bushel	—	3 03	3 03	3 03
ARP	Percent	—	—	10	175
PLD	Percent	—	—	—	025
Loan rate	Dollars/bushel	—	—	2 55	1 84
Excess supply equation					
Slope	—	1,282 88	845 786	1,489 33	1,608 62
Intercept	1,000 bushels	- 98 107	1,434 36	- 1,086 00	- 1,512 89
Excess demand equation					
Slope	—	- 380 000	- 380 000	- 380 000	- 380 000
Intercept	1,000 bushels	2,347 000	2,347 000	2,347 000	2,347 000
World price	Dollars/bushel	1 47	0 75	1 85	1 94
U S exports					
Without loan	1,000 bushels	1,788	2,062	1,645	1,609
With loan	1,000 bushels	—	—	1,378	[1]
Export subsidy (tax) equivalent					
Without loan	Dollars/bushel	0	0 94	(0 49)	(0 61)
With loan	Dollars/bushel	—	—	(1 40)	(0 61)

ARP = Acreage reduction program
PLD = Paid land diversion
— = Not applicable
[1] Loan rate is below market price, hence, loan is an ineffective floor price

Note that all the equations in FAPSIM are linear Many points at lower price levels on the "no program" excess supply curve that were used to calculate the equivalent export taxes represent out of-sample observations The excess supply curve would probably be nonlinear at very low price levels, making the equivalent export taxes somewhat smaller than those estimated here

Policy Implications

For the current program to be a true subsidy as is often alleged, a combination of changes would be required that would allow the market price to fall below the "no program" price estimated at $1 51 per bushel for wheat or $1 47 per bushel for corn It would be necessary to retain the target price and deficiency payment program, although not necessarily at the same level, and to further reduce the loan rate, either by lowering the price-support loan or by using some form of marketing loan Some easing of the acreage reduction requirement or a relaxation of the rules so that greater slippage could occur would also be necessary

The Ontario Corn Growers Association charged that corn imports from the United States were being subsidized through the U S farm support programs The analysis here suggests that, on the contrary, the current program acts as a significant export tax on corn equal to about 31 percent of the market price However, the implicit tax on corn is $0 79 per bushel lower because of the changes made by the Food Security Act of 1985, the Balanced Budget and Deficit Control Act of 1985, and the 1986 crop year program If the 1985 crop-year program were in effect, the equivalent export tax would be about 55 percent of the market price of corn The significant difference in the magnitude of the implicit export tax would help explain why Canadian producers have felt injured and why they have been under increased pressure since passage of the 1985 Act

Appendix

USDA's FAPSIM model is well suited to estimating the net effects of domestic programs on the excess supply facing world markets because program participation, and particularly slippage, heavily influence whether the program acts as an export subsidy or an export tax FAPSIM uses an approach that endogenously determines the planted acreage both inside the program and outside the program The equation is based on the historical relationship between participation and expected net returns from program participation and from the market The participation relationship captures the effect of slippage due to additional acreage planted by nonparticipants

Expected net return from participating or from not participating is an important component of the farmer's decision For a program participant, the expected net per-acre return for crop i is

$$
\begin{aligned}
EPR_i = {} & [(EPP_i * EY_i - VC_i)(1.0 - (ARP_i + PLD_i))] \\
& + [SR_i * PY_i (1.0 - (ARP_i + PLD_i))] \\
& + [DR_i * PY_i * PLD_i]
\end{aligned} \tag{1}
$$

where

EPR_i = expected program net return per acre for crop i,
EPP_i = maximum of the loan rate and the expected market price,
EY_i = expected yield per acre,
VC_i = variable cost per acre,
SR_i = expected deficiency payment rate (target price less maximum of expected market price or loan rate) per bushel,
PY_i = national program yield,
ARP_i = proportion of each acre in unpaid acreage reduction,
PLD_i = proportion of each acre in paid land diversion and
DR_i = diversion payment rate per bushel

The expected net return per acre for nonparticipants is

$$EMR_i = EMP_i * EY_i - VC_i$$

where

EMR_i = expected market net return per acre for crop i,
EMP_i = expected market price for crop i, and
EY_i, VC_i defined as above

Expected crop prices are based on the simple average price 1-5 months prior to planting, and expected crop yields are obtained by regression of actual yields on time

The expected net return variables are used to estimate acreage response by participants and nonparticipants Acreage planted in the program is expressed as

$$
\begin{aligned}
PA_i = {} & f\,[EPR_i, EMR_i, APP_i, \\
& (1 - ARP_i - PLD_i)]
\end{aligned} \tag{3}
$$

where

PA_i = program acreage of crop i,
APP_i = average expected net return of competing crops,
ARP_i = acreage reduction percentage for crop i, and
PLD_i = paid land diversion percentage for crop i

The slippage is accounted for in the acreage planted equation for nonparticipants, which is a function of acreage planted to the crop by participants, acreage set aside and diverted, the real expected net return from competing crops, and the real expected market net return from planting crop i

The model also incorporates yield equations that are a function of, among other things, the planted acreage both inside and outside the program Incorporation of planted acreage into the yield equations takes into account the common practice of retiring the least productive land first when an acreage reduction program is in effect, and that factors of production other than land are not controlled

The yield equation is expressed as

$$YLD = f(TIME, IDLE, PLANT) \tag{4}$$

where

YLD = yield per acre,
IDLE = acreage idled by program participants,
PLANT = total planted acreage, and
TIME = a time trend

The complete set of equations and summary statistics appear in (*2*)

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In Earlier Issues

New work, like that reported in this article, conducted under the Occupation in two hemispheres, is giving BAE a chance to observe the effectiveness of modern sampling techniques

How complete is a "complete" census? [T]he Japanese Crop Reporting Service, newly organized, has a more specific answer Incompleteness proved to be of two kinds (1) nonreporting of fields in these crops and (2) understatement of the area of the fields reported

A measure of bias to nonreporting of hitsu was obtained from a sample of some 37,000 koaza in which all the hitsu in the specified crops reported by farmers in the census were checked by the Branch Crop Reporting Offices against the plot maps in the land ledger, and the area of nonreported hitsu was estimated through inspection, usually by taking the area of the hitsu as recorded in the land ledger A measure of bias due to understatement of the area in the specified crops as reported by the farmers on the census was obtained from a randomly selected subsample of hitsu within the sample koaza These 70,000 subsample hitsu were actually measured by plane table surveying methods

Charles F Sarle
Vol 1, No 2, Apr 1949