Disentangling the Production and Export Consequences of Direct Farm Income Payments

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1. Introduction

Agricultural support programs designed to protect farmers have undergone major reforms worldwide since the inception of the Uruguay Round of trade negotiations in the mid 1980s. The impetus for these reforms included the economic inefficiencies and budget costs generated by these programs, in addition to international pressures to minimize trade distortions. United States major field crops policy has undergone significant changes since the 1985 Farm Bill were program yields were 'frozen', thereby starting the trend towards decoupling of the target price that was finalized in the 1996 FAIR Act.[1] Likewise in the European Union, partially decoupled programs for major agricultural sectors were implemented through supplementary direct income payments. This program was initiated in the McSharry reforms of the early 1990s, and broadened in the EU's Agenda 2000 of the recent Berlin Accord. Canadian agricultural policy has also undergone major changes for a subset of the protected sectors, terminating several programs[2] and replacing them with direct income support payments through NISA.

The effect of domestic subsidy programs on world trade has become an important policy issue, not least for the current agricultural trade negotiations. In an unprecedented act, WTO disciplines on agricultural support include domestic programs that encourage production. 'amber' and 'green' policy 'boxes' are used to differentiate those policies that seriously distort trade from those with minimal trade effects. A key issue in the current WTO negotiations on agriculture will be the domestic support reduction commitments (measured by the "aggregate measure of support" or AMS) and the determination of which policies go in the 'green' *versus* 'amber' or 'blue' box categories. Given the reform efforts of governments in agricultural policies

[1] The loan rate remains fully coupled, however, through 'loan deficiency payments'.

[2] For example, the Agricultural Stabilization Act (ASA), the Western Grain Stabilization Act (WGSA) and subsidies under the Western Grain Transportation Act (WGTA) have been terminated, and the National Tripartite Stabilization Program (NTSP) and the Gross Revenue Insurance Program (GRIP) are being phased out.

for efficiency concerns and the ongoing trade negotiations, it has become increasingly important to understand the effect of farm programs on output response. This is particularly true when the degree of decoupling has become murky. Many policies involve transfers from consumers or taxpayer financed income payments that are partially decoupled like fixed payment yields, and payments based on both acreage planted and acreage diverted. Previously, agricultural policies were rather straightforward and fully coupled with import barriers, open ended price supports or export subsidies. The current trend is towards varying degrees of decoupled policies.

The purpose of this paper is to identify the impacts of taxpayer and consumer financed infra-marginal production subsidies to farmers through the effects on fixed costs.[3] In particular, income transfers to farmers like the peanut quota or base acreage and direct income payments for wheat can cover *fixed costs*, thereby allowing a farmer who may otherwise have exited the industry to stay in business, and perhaps even expand output beyond the quota or base acreage.[4] In this light, we identify production related factors that impact the magnitude of necessary transfers and prioritize various means of subsidy finance, such as consumer financed subsidies via trade measures, or taxpayer financed subsidies via direct payments.

To begin, we assume that these payments are fully de-coupled in the traditional sense. Taking the example of U.S. peanuts and wheat in Figure 1, point *a* is always to the right of point *b* in each panel of Figure 1. Hence, the effects of a consumer transfer policy on demand and consequently on trade distortion is straightforward from panel (a) of Figure 1. Transfers are area *c* in panel (a) and areas $c + d$ in panel (b). $\underline{Q}$ is the peanut quota, T is the wheat target price, s is the per unit production subsidy for wheat, and $\underline{B}$ is the wheat base acreage. The effects on production are indirect in that fixed costs are affected. The exposure to world markets (i.e., the

[3] "Infra-marginal" means the marginal cost for output receiving income payments is below the world price.

ratio of exports to production), in addition to market parameters will determine the extent of output expansion. The model explicitly recognizes several consequences of domestic support: (a) induce exit or entry; (b) bias production incentives in domestic markets; and (c) cross-subsidize export in global markets.

One can identify three broad categories of policies that encompass most "direct farm income payment schemes" in agriculture worldwide of infra-marginal income payments (e.g., ABC quotas for sugar in EU, peanut quota in the US and fluid milk quotas in California), an infra-marginal taxpayer financed income payment (former US crop policy with fixed payment yield and base acreage), infra-marginal direct income payment with a fixed per unit production subsidy *s* financed by taxpayers (e.g., EU oilseeds and cereals), and infra-marginal income payments financed by taxpayers but the income payments are fixed per farm (based on historical production) but farmers do not have to produce to get payments so (e.g., current U.S. production flexibility contract payments and emergency assistance payments).

Our focus on this paper is to develop a generalized model of how payments can affect fixed costs so to further our understanding of the importance of domestic support programs on global competitiveness. We use the U.S. peanut and wheat sectors as examples. To this end, we develop a framework isolating factors affecting the competitiveness of agriculture in terms of two major categories of domestic farm support: direct payments (e.g., production flexibility payments for wheat) and consumer transfers with price supports (peanuts). We therefore isolate the production response of income transfers depending on whether it is taxpayer or consumer financed. Payments cover fixed costs, and thus affect producer responses ranging from outright market exit to cross-subsidizing (promoting) exports. By explicitly recognizing the presence of

[4] The approach also allows for the potential effect of decoupled payments on investment, given the specialized skills of farmers and imperfect labor, information and capital markets (Roberts, Skees).

fixed costs, this paper brings to bear the effect of direct payments may have on strategic export policies in disguise. In this context, the urgent issue facing policy makers is to prioritize policies as to their impact on exports. Different types of domestic policies have differential effects on the level of farm income and production costs, thus affecting exit/entry and/or production beyond domestic use in cross-subsidizing exports. The value-added of this research paper is to provide a coherent framework that makes explicit the role of farm support in world trade, and to develop relevant criteria on how programs can be classified in order to improve the effectiveness of current domestic support policies.

The empirical framework will involve calibrating the production and cost structure of a typical farm type for the peanut and wheat sectors to illustrate the usefulness of the analysis and how outcomes depend on, *inter alia*, prices, demand, and cost variables specific to the industry in question. Empirical simulations of the relevant criteria that link global trade competitiveness with domestic farm support will aid in understanding the relative effects of the various factors identified.

2. Background

Direct government payments in the U.S. crop sector have peaked at $22.7 billion in 1999 (see Table 1). Consumer financed infra-marginal production subsidies include peanut and sugar quotas in the United States and the European Union, respectively, and supply management programs in Canada can act like an export subsidy because of higher domestic prices imply a decrease in consumption and production expands because infra-marginal payments helps pay for fixed costs.[5] Consumer financed transfers are also high in the case of U.S. peanuts where domestic prices are over 50 percent higher than world prices (see Table 4). It is possible for these direct income payments to affect output regardless if the farmer is required to produce the product in order to obtain the payment (like in peanuts) or not (as in wheat).[6] Tables 2 and 3 give costs of production for wheat per farm (by farm size) and per acre, respectively. Table 4 presents the fixed cost breakdown for peanuts. In the United States, fixed costs are higher than variable costs for peanuts and cotton. The fixed costs for wheat are among the lowest of all crops in the United States relative to total costs.

To motivate the effect of the income payment on output through its effect on fixed costs, consider a payment base B in Figure 2 for a small country exporter with payments equal to the sum of area *a* and *b*. World prices are below the average total costs so this farmer would ordinarily exit the industry and produce nothing. Total fixed costs are area *b, c, d* and *e*. Because point $f < P_d$, these fixed costs are covered if the farmer produces at B. Otherwise, the farmer exits the industry. If it is profitable to produce at point B, it is also profitable to produce at Q if and only if the world price P_w is greater than the minimum of the AVC curve. Hence, there are three discrete production outcomes that can be affected with direct income payments: Q, B or O in Figure 2. However, if the world price is above the minimum of the ATC curve, then income payments have no impact on output.

Do such programs constitute "cross-subsidization"? This is an important issue, given the many sectors with such programs in the United States, European Union and Canada, especially given the recent WTO Panel decision on Canadian dairy pricing. The farmer maximizes total profits in one operation: producing a product for two markets. There are three zero-one potential outcomes: exit (or do not enter), produce base only, or produce where the world price equals

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[5] Consumer financed infra-marginal production subsidies are unique in that it involves price discrimination and so requires import controls and an additional trade distortion not applicable to taxpayer financed infra-marginal production subsidies. This may have implications for trade law.
[6] We assume the right to income payments is freely tradable across farms.

marginal cost and so export as well. A necessary but not sufficient condition for exports to occur is for the world price to equal marginal costs between the minimums of the ATC and AVC curves. Cross-subsidization requires profits from one operation to offset losses from another (required to lose money in an operation). The question arises: why would a firm want to finance losses in one operation with profits from another operation?

In Figure 3, a farmer is only able to produce at Q' with P_w' if net losses on total production given by the hatched area is less than excess rents to cover it, given by the cross-hatched area. Otherwise, he is unable to stay in business. If he were rational, he would produce at B regardless. If he stays at Q' with P_w less than the minimum of the average variable costs of production, then he is irrational to sell for export (and if the hatched area is greater than the cross-hatched area, then he will be forced out of business and pay for his irrationality in not producing at B only and making a profit). One reason perhaps why a firm may do this is the waiting game of having other firms exit the industry first and so prices will increase in the future. This is something like a predatory pricing strategy perhaps (although the farmer really is not a monopoly).

Therefore, cross subsidization may be a problem for infra-marginal production subsidies where farmers also produce at the lower world price. Farmers do have to decide to either produce for the domestic market only, for both markets, or exit the industry.

A general methodology is developed to show the conditions under which a firm would choose each of the three options, the degree of distortion (relative size of B versus Q, the slope of MC, the level of fixed costs to total costs, the level of payments, etc.). We then evaluate industry output in aggregate and analyze the distribution of cost structures and farm sizes to link conditions determined for an individual firm to aggregate industry output.

3. The Basic Model

Production

We envisage an economy in which a large number (N) of producers are engaged in the production of an output x. Individual producers are endowed with production technologies: $x = G(L_x)$. G is taken to be strictly concave and twice continuously differentiable in a composite variable input (L_x). We assume that perfect competition prevails in factor and output markets, and producers take factor rewards w along with world price p, as exogenously given. Define the cost function of an individual producer as:

$$C(x, F) = \min_{L_x} \; wL_x - F, \;\; s.t. \;\; G(L_x) \geq x.$$

where $F \in [F^-, F^+]$ is taken to be a firm specific fixed cost parameter. The distribution of the N firms in the range $[F^-, F^+]$ is given by a cumulative distribution function $m(F)$, with $m'(F) \geq 0$.

Consumption

Consumption demand of x in the economy is characterized by a demand function $D(q)$, with $D'(q) \leq 0$, where q denotes the price of good x facing consumers. The link between domestic consumer price q and world price p depends on the commercial policy regime. In particular, let $q > p$ be a target domestic price to be received by domestic producers only, and $D(q)$ be the associated domestic demand.

Export Subsidies

The two-stage profit maximization problem of an individual entrepreneur involves (I) the decision as to whether or not to incur the fixed cost F, and (II) the choice of an output level given the competitive market returns to factor inputs, along with domestic q and world price p. We begin with the second stage problem. Let the magnitude of coupled and decoupled income support be given by an *ad valorem* subsidy s and a lump sum subsidy M respectively. Since q denotes unit revenue for $x \le d$, the profit function is given by:

$$\begin{aligned} &\max{}_x \; p(1+s)(x-d) + qd - C(x,F) + M \\ = &\max{}_x \; p(1+s)x - C(x,F) + (M + [q - p(1+s))d]. \end{aligned} \qquad (2)$$

where q denotes the domestic target price. Two observations are in order: First, infra-marginal consumer-financed subsidies in the context of producer preferences that exhibit risk neutrality is equivalent to a lump sum decoupled payment of the amount $q - p(1+s)d$. Second, denote $x^*(p,s)$ as the profit maximizing output level, and $e^*(p,s,d) = x^* - d$, it follows that the profit function can be written as:

$$\begin{aligned} &p(1+s)e^* + qd - C(e^* + d, F) + M \\ = \; &p(1+s)e^* - C(e^* + d, F) + (M + qd) \\ \equiv \; &\boldsymbol{p}(p,s,d,q,M,F) \end{aligned} \qquad (3)$$

Routine manipulation yields the standard price equals marginal cost condition:

$$p(1+s)e^* - C_x(e^* + d, F) \le 0, \qquad (4)$$

with complementary slackness. Specifically, the firm exports strictly positive amount (e^*> 0) of good x if and only if $p(1+s)e^* - C_x(e^* + d, F) > 0$.

Accounting for equation (3) above, an individual firm is better off incurring the fixed cost F if and only if:

$$\boldsymbol{p}(p,s,d,q,M,F) \ge \boldsymbol{r}, \qquad (5)$$

where $\boldsymbol{r}$ denotes the income available from the next best alternative for the entrepreneur. Since the left hand side of equation (3) is strictly decreasing in F, define:

$$\hat{F}(p,s,d,q,M,F) = \{F \mid \boldsymbol{p}(p,s,d,q,M,F) = \boldsymbol{r}\}, \qquad (6)$$

$\hat{F}$ thus represents the fixed cost required by the marginal entrepreneur, such that

$\pi(p,s,d,q,M,F) \geq 0$ if and only if $F \leq \hat{F}$. Note, in particular, that $\hat{F}$ is strictly decreasing in domestic input costs *w*, while an increase in world price *p*, and direct payment either coupled *s* or decoupled *M* widens the range of producers who commit to production by incurring the producer specific fixed cost *F*.

Finally, $\hat{F}$ is strictly increasing in *q*, if and only if marginal revenue is strictly *less than* marginal cost when domestic $q + (D(q)/D'(q)) - C_x \leq 0$. The intuition of the latter result is straightforward. Since an increase domestic price q requires a corresponding decrease domestic consumption, aggregate profit of the individual producer increases whenever the marginal revenue losses subsequent to output reduction is strictly less than the corresponding cost savings. Given the definition of $\hat{F}$ above, the number of firms with positive output levels is given simply by $\hat{N} = Nm(\hat{F})$.

3.1 Output, Export Volume and Welfare

Equation (4) allows us to define aggregate export volume as:

$$E^* \equiv N \int_{F^-}^{\hat{F}} e^* dm(F) = Ne^* m(\hat{F}), \tag{7}$$

Let $\phi(\in[0,1])$ parameterizes the excess burden of taxpayer financed subsidy payments (Moschini and Sckokai), so that $M^f \equiv (1+\phi)M$ and $S^f \equiv (1+\phi)spx^*$ represent the per-producer cost of financing decoupled and coupled payments. Making use of equation (4) above, it can be readily verified that,

$$\frac{\partial x^*}{\partial M^f} = 0; \qquad \frac{\partial x^*}{\partial S^f} = \frac{\Omega}{1+\phi} \frac{\partial x^*/\partial s}{px^* + sp(\partial x^*/\partial s)} \tag{8}$$

$$\frac{\partial \hat{F}}{\partial M^f} = \frac{\Omega}{1+f}; \qquad \frac{\partial \hat{F}}{\partial S^f} = \frac{\Omega}{1+f}\frac{p(x^* - d)}{px^* + sp(\partial x^*/\partial s)} < \frac{1}{1+f} \tag{9}$$

where $\Omega = \left(1 + (q - p(1+s)/[N(m(\hat{F}))^2 m'(\hat{F}))]\right)^{-1} > 0$. Thus, although decoupled payments are relatively less distorting than coupled payments in terms of the output choices of individual producers ($\partial x^*/\partial M^f < \partial x^*/\partial S^f$), equation (9) above shows that decoupled payments are nevertheless relatively {\it more distorting} in terms of aggregate output since ($\partial \hat{F}/\partial M^f > \partial \hat{F}/\partial S^f$). Figure 4 illustrates the intuition behind this result. In particular, an increase in coupled subsidy rate increases the producer price from *p* to *p(1 + s)*, with an associated increase in subsidy expenditure (assuming here that $f = 0$) that is given by the area A, B, C and D. Nevertheless, area B and C represent the corresponding increase in producer profit only. Simply put, area D is dissipated as output increases from x_1 to x_2 necessitates a corresponding increase in (marginal) production cost associated with the increase in output from *p* to *p(1 + s)*. Meanwhile, area A (> 0 whenever *d* > 0) represents a net transfer of government revenue to consumer surplus, as the wedge between consumer (*q*) and producer price *p(1 + s*) falls with *s*.

In addition, denote aggregate output as $X^* = Nm(\hat{F})x^*$. We have,

$$\begin{aligned} \frac{\partial X^*}{\partial M^f} &= Nm'(\hat{F})\frac{\Omega}{1+f} \\ &> Nm'(\hat{F})\left(\frac{\Omega}{1+f}\frac{p(x^* - d)}{px^* + sp(\partial x^*/\partial s)}\right) + Nm(\hat{F})\frac{\partial x^*}{\partial s} \\ &= \frac{\partial X^*}{\partial S^f} \end{aligned}$$

if the exit deterrence impact of decoupled payments $m'(.)$ is sufficiently large -- an empirical matter depending on the actual distribution of fixed costs across firms.

Likewise, since consumer surplus *CS* is given by $CS = \int_q^{\infty} D(z)dz$, we have

$$\frac{\partial q}{\partial CS} = -\frac{1}{D(q)}.$$

In order words, a small reduction in consumer surplus renders possible a corresponding increase in domestic target price by the amount *1/D(q)*. It follows, therefore, that the tradeoff between domestic consumer surplus *losses*, and the degree of output distortion on the part of individual producers is given simply by:

$$-\frac{\partial x^*}{\partial CS} = 0; \tag{10}$$

$$-\frac{\partial \hat{F}}{\partial CS} = \Omega\left(1 - \boldsymbol{h}\frac{q + C_x}{q}\right) > (\leq) 0. \tag{11}$$

if and only if marginal revenue of the domestic demand curve evaluated at the target *price q - q/* $\boldsymbol{h}$ is strictly less than (greater than) marginal cost C_x. Indeed, aggregate output is strictly decreasing in *CS*, or equivalently, X^* increasing in *q*, with,

$$-\frac{\partial X^*}{\partial CS} = N\Omega\left(1 - \boldsymbol{h}\frac{q + C_x}{q}\right)$$
$$< (\geq) N\Omega m'(\hat{F})\frac{1}{1 + \boldsymbol{f}} = -\frac{\partial X^*}{\partial M^f}$$

if and only if

$$1 - \boldsymbol{h}\frac{q + C_x}{q} < (\geq) \frac{1}{1 + \boldsymbol{f}}$$

It follows, therefore, that infra-marginal consumer financed subsidy payment is *less output distorting* than taxpayer financed subsidy payment if and only if the elasticity of domestic demand is sufficiently high, or if excess burden of taxpayer finance $\boldsymbol{f}$ is sufficiently small.

Turning now to total producer surplus, let PS be given by

$PS = N\int_{F^-}^{\hat{F}} \pi(p, s, d, q, M, F)\,d\mu(F)$. It is straightforward to verify that

$$\begin{aligned}\frac{\partial PS}{\partial M^f} &= N\mu'(\hat{F})\frac{\Omega}{1+\phi}\hat{\pi} + N\mu(\hat{F})\frac{1}{1+\phi}\\ &> N\mu'(\hat{F})\left(\frac{\Omega}{1+\phi}\frac{p(x^*-d)}{px^* + sp(\partial x^*/\partial s)}\right)\hat{\pi} + N\mu(\hat{F})\frac{1}{1+\phi}\frac{p(x^*-d)}{px^* + sp(\partial x^*/\partial s)}\\ &= \frac{\partial PS}{\partial S^f}\end{aligned}$$

if the exit deterrence impact of decoupled payments *m'(.)* is sufficiently large.

Likewise, the tradeoff between domestic consumer surplus *losses*, and the producer surplus is given simply by:

$$\begin{aligned}-\frac{\partial PS}{\partial CS} &= N\Omega\mu'(\hat{F})\left(1-\eta\frac{q+C_x}{q}\right)\hat{\pi} + N\mu(\hat{F})\left(1-\eta\frac{q+C_x}{q}\right)\\ &< (\geq) N\Omega\mu'(\hat{F})\frac{\Omega}{1+\phi}\hat{\pi} + N\mu(\hat{F})\frac{1}{1+\phi} = -\frac{\partial PS}{\partial M^f}\end{aligned}$$

if and only if

$$1-\eta\frac{q+C_x}{q} < (\geq)\frac{1}{1+\phi}$$

3.2 Calibration

Let the following functional forms apply:

$$G(L_x) = L_x^a$$

$$D(p) = a - bp$$

where $a, b > 0$ are demand parameters. In addition, let fixed cost be a normally distributed random variable.[7] It follows that the cost function is given by:

$$C\,(x, F) = \boldsymbol{a} x^{1/\boldsymbol{a}} (w/\boldsymbol{a}) + F.$$

In addition, the profit maximizing total output and export levels, along with the profits of an individual producer are given by:

$$x^*(p,s) = (p(1+s))^{\frac{1}{1-a}} \left(\frac{\boldsymbol{a}}{w}\right)^{-\frac{a}{1-a}} \tag{12}$$

$$e^*(p,q,d,s) = (p(1+s))^{\frac{1}{1-a}} \left(\frac{\boldsymbol{a}}{w}\right)^{-\frac{a}{1-a}} - (a - bq) \tag{13}$$

$$\boldsymbol{p}^*(p,q,d,s,M,F) = (1-\boldsymbol{a})(p(1+s))^{\frac{1}{1-a}} \left(\frac{\boldsymbol{a}}{w}\right)^{-\frac{a}{1-a}} - F + M + (q - p(1+s))(a - bq) \tag{14}$$

As a benchmark, consider the case whereby the endogenous entry / exit decisions of producers are not accounted for, so that $N = \hat{N}$ throughout, output distortion due to the joint application of consumer-financed, coupled and decoupled payments is given simply by:

$$N(x^*(p,s) - x^*(p,0)) = N((1+s)^{\frac{1}{1-a}} - 1)\, p^{\frac{1}{1-a}} \left(\frac{\boldsymbol{a}}{w}\right)^{-\frac{a}{1-a}} \tag{15}$$

Clearly, infra-marginal subsidy payments have no output consequences as x^* is independent of M and q.

Turning now to the definition of the *marginal* producer, who is just indifferent between exit, or maintaining positive output levels, we have

[7] As such, producer profits are also distributed according to a normal distribution.

$$\hat{F}(p,q,d,s,M,F) = (1-\alpha)(p(1+s))^{\frac{1}{1-\alpha}}\left(\frac{\alpha}{w}\right)^{-\frac{\alpha}{1-\alpha}} + M + (q - p(1+s))(a - bq) \qquad (16)$$

$$q = \left(a - Nm(\hat{F})\right)/b, \qquad (17)$$

Equations (12) - (13) thus constitute two equations in $\hat{N}$ and d that can be used to simultaneously determine the fixed cost level of the marginal producer, along with the output level upon which consumer-financed subsidy payments is made to each producer.

Thus, aggregate output distortion due to the joint application of consumer-financed, coupled and decoupled payments can be readily decomposed into three components, with:

$$\begin{aligned} X^*(p,q,s,M) - X^*(p,0,0,0) = (p)^{\frac{\alpha}{1-\alpha}}\left(\frac{\alpha}{w}\right)^{-\frac{\alpha}{1-\alpha}}\Big(&\left[m(\hat{F}(s,0,0))(1+s)^{\frac{\alpha}{1-\alpha}} - m(\hat{F}(s,q,M))\right] \\ &+ \left[m(\hat{F}(0,q,M)) - m(\hat{F}(0,0,M))\right] \\ &+ \left[m(\hat{F}(0,0,M)) - m\hat{F}(0,0,0)\right]\Big). \end{aligned} \qquad (18)$$

where the expressions in square brackets respectively denote output distortions that are due to coupled, consumer-financed, and taxpayer financed decoupled income payments, all of which can be computed once the following parameters are given: input share (α), input price (w), world and domestic consumer prices (p and q), along with the distribution of fixed costs across firms $m(F)$, and consumption demand parameters a and b.

In a similar fashion, aggregate export distortion depends on:

$$\begin{aligned} E^*(p,q,d,s,M) - E^*(p,0,0,0,0) = X^*(p,q,s,M) - D(q) - [X^*(p,0,0,0) - D(p)] \\ + p^{\frac{\alpha}{1-\alpha}}\left(\frac{\alpha}{w}\right)^{-\frac{\alpha}{1-\alpha}}\Big(&\left[m(\hat{F}(s,0,0))(1+s)^{\frac{\alpha}{1-\alpha}} - m(\hat{F}(s,q,M))\right] \\ &+ \left[m(\hat{F}(0,q,M)) - m(\hat{F}(0,0,M))\right] \\ &+ \left[m(\hat{F}(0,0,M)) - m\hat{F}(0,0,0)\right]\Big) + [D(p) - D(q)]. \end{aligned} \qquad (19)$$

4. Calibration Results

Section 3 lays the foundation for the calibration results summarized in tables 5 to 7, where the output, export and producer welfare consequences of U.S. wheat policy are examined. To begin with, the variable costs information in Table 2 is used in conjunction with the data on gross cash income to yield the variable cost share parameter a. With LDP per bushel given by \$0.19 per bushel in 1998, the implied market price of wheat is \$2.39 per bushel. These parameters, along with equation (12) above allow us to calibrate farm-level output levels in Table 5. Specifically, in the absence of the possibility of exits, total output falls by 265.42 million bushels (10.42% reduction) in event of a removal of coupled LDP payments. Thus, the implied elasticity of aggregate supply is 1.31. In addition, making use of equation (13), removal of LDPs implies a reduction in aggregate exports from 1,505.6 to 1,041.7 million bushels – a 30.81% reduction, at constant world market price (\$2.39 per bushel) (Table 6).

The change in profits due to LDPs can also be computed using equation (14). These results are presented in Table 7. Note that for every sales class, LDP payment exceeds the increase in variable profits. This is in consonance with our discussion in section 3 above, wherein deadweight losses (area D in Figure 4) are associated with coupled subsidy payments, so that a dollar increase in government expenditure on LDPs translates to less than one dollar increase in producer profits. The computed total deadweight loss associated with coupled LDP payment in 1998 is \$25.265 million.

Turning now to incorporate the possibility of exits, Table 6 provides the output and export responses to three policy regimes: (I) removal of LDP payments only (II) removal of AMTA only and (III) removal of both AMTA and LDP. Since we are limited by the level of data disaggregation in our data set, we limit the group of farms that are most vulnerable to exit to farms with sales less than $50,000 – the only group of farms with negative computed profits (Table 6). As in Section 3.2, we assume that farm profits are distributed according to a normal distribution. The projected numbers of farms with negative profits in Table 7 are thus determined once the mean and the standard deviation of computed farm profits are computed.

Recall from the discussion in equations (8) and (9) that whereas coupled subsidies are more output distorting in the absence of an exit option, decoupled subsidies are nevertheless more effective in deterring exit since the question of deadweight losses (other than the excess burden of financing direct income payments) does not arise. The results provided in Table 6 are representative of these analytical results. To begin with, note that by accounting for the possibility of exit by farms with negative projected profits upon removal of LDP payments (leaving the decoupled component of direct income payment intact), total output is 2171.81 million bushels – an additional reduction of 110.7 million bushels (a total reduction of 375.5 million bushels, or 14.74% of the 1998 benchmark). This can be attributed to the aggregate output reduction if 11,368 farms (54.1%) in the $50,000 sales class abandon wheat production altogether. Meanwhile, removal of AMTA payments implies negative profits for a strictly larger number of farm units (12,411 farms, 59.07%), while the implied aggregate output level due only to the removal of AMTA payments is 2396.84 million bushels – a reduction of 150.46 million bushels (5.9% of 1998 status-quo). Thus, as long as existing farms continue to produce with coupled subsidies in place, the (coupled) subsidy-induced increase in output of the existing farms more than compensate for the negative output response as farms belonging to the smallest sales class exit the industry once AMTA payments are removed. Finally, removing both AMTA and LDP payments triggers a reduction in total output that is equal to 390.25 million bushels (15.3% of 1998 benchmark).

The degree of export cross-subsidization via direct income payments can also be ascertained when fixed costs and the potential exits of farms are duly taken into account. Thus, at constant (1998) market price, the implied level of exports is 651.47 million bushels (as compared to 1505.6 million bushels in 1998) – the smallest of all three potential policy scenarios under consideration when the possibility of exit is taken into account. This is followed by the case whereby only LDP payments are removed (666.21 million bushels), and the case with AMTA payment removal (891.24 million bushels).

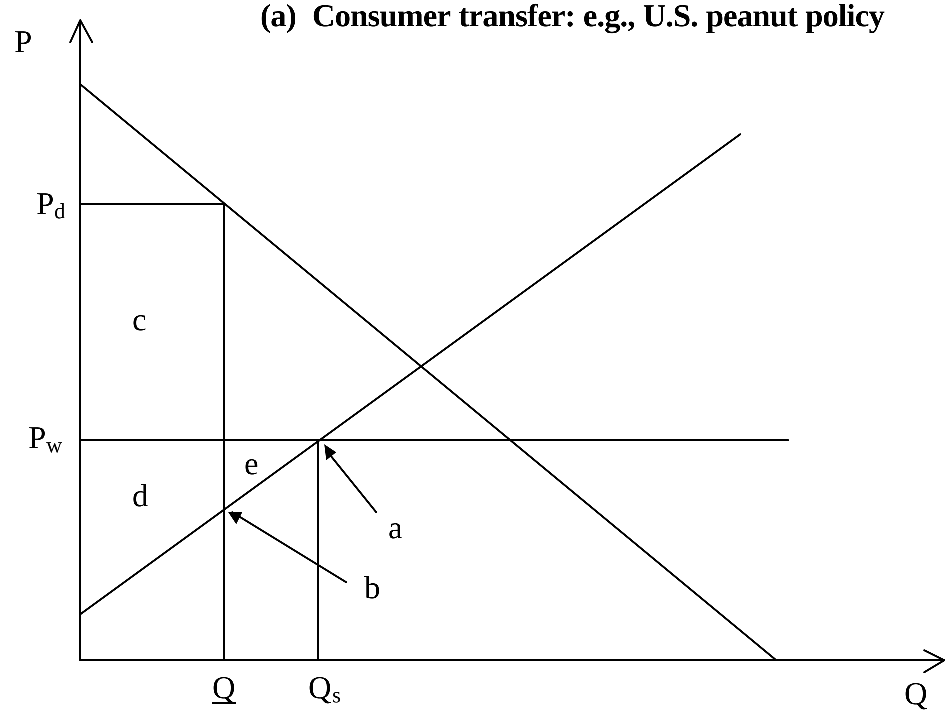
5. Conclusion

This paper proposes an analytical framework based on the premise that fixed costs and the decision to exit impact aggregate production, and hence export consequences of direct income payments. In particular, even though decoupled payments do not affect production decisions at the margin (Collins and Vertrees), the exit deterrence effect of decoupled payments can potentially be more output distorting than coupled payments, once the deadweight losses associated with coupled payments are taken into account (section 3.1). Meanwhile, to the extent that aggregate output depends on the decision to exit, direct income payment can cross-subsidize exports, and distort international trade flows depending on the distribution of fixed costs across individual farm units. Attempts to evaluate the relative merits of decoupled and coupled payments based on their impact on aggregate trade flows and producer welfare should accordingly take into account the impact that both marginal and infra-marginal payments may have on aggregate output, and export levels.

In this exploratory study, we take wheat production in the U.S. as a case in point. The calibration framework laid out in section 3.2 is employed to study the output and export consequences of three policy scenarios, having to do with the removal of LDP payments, AMTA payments, and both. The results are broadly consistent with our analytical findings, in that whereas removal of decoupled payments can have a relatively large impact on the exit decision on low-profit farm units, its aggregate output impact can remain quite limited so long as the output level of the *marginal farm* is relatively small. Clearly, these results are sensitive to the distribution of AMTA payments across farm size, along with the *reservation profit* of the marginal farm. Thus, if reductions in decoupled payments are biased in such a way as to disproportionately favor low output farms, the exit deterrence consequence of direct income payments may imply a much smaller output and export distortion than suggested in this study. Meanwhile, if existing income payments generates expectation of future payments that compensates short-term losses, the reservation profit of the marginal farm may take on a negative value and the aggregate output and export distortion of decoupled payments can accordingly be considerably larger. Also of interest seems to be the possibility of the interaction between risk-induced production distortion, and the way in which direct income payment impacts producers' attitudes towards risk. The resulting output and export distortion should therefore appropriately account for: (I) direct payments as a corrective policy in the face of risk aversion (Bhagwati); (II) the risk aversion impact of direct payment in the presence of non-constant rate of risk aversion (Hennessy; de Gorter and Tsur) and (III) the risk exposure effect of infra-marginal consumer financed export subsidies when barriers to trade also provide an income safety net for agricultural producers. Much more work clearly remains to be done in this area.

Figure 1: De-coupled Consumer *vs.* Taxpayer Financed Infra-marginal Production Subsidies

(a) Consumer transfer: e.g., U.S. peanut policy



(b) Taxpayer transfer: T fixed (e.g., pre-FAIR U.S. policy) or *s* fixed (e.g., U.S. PFCs)

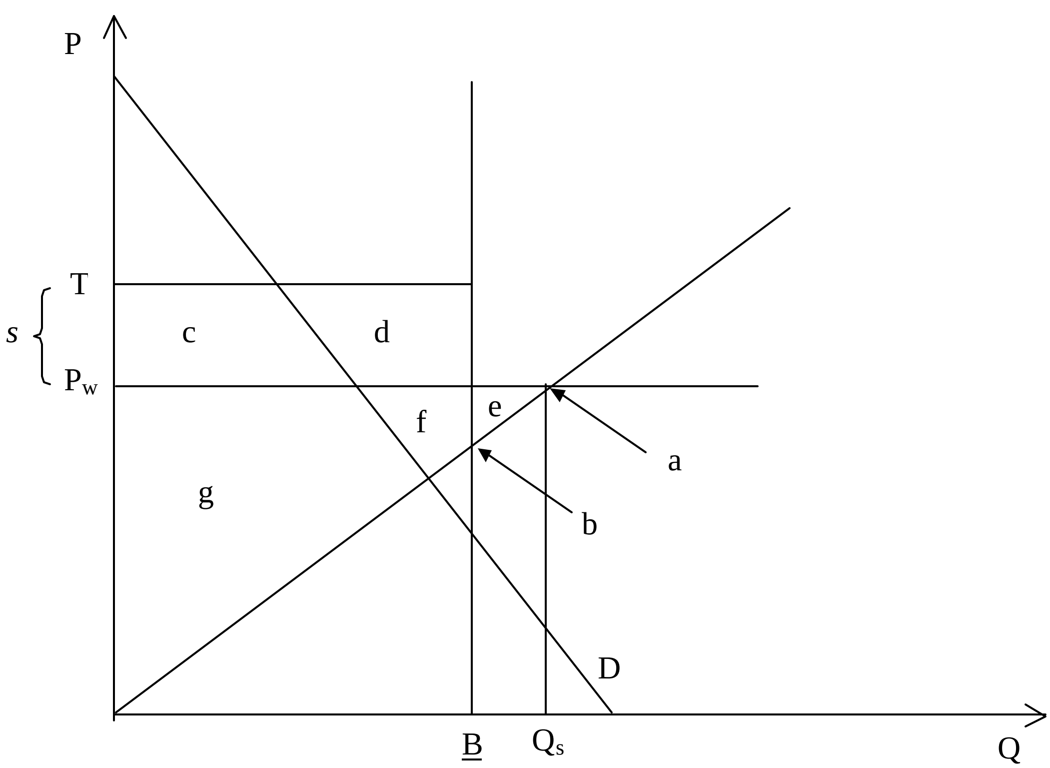


Figure 2: Effects of Direct Income Payments on Fixed Costs and Output

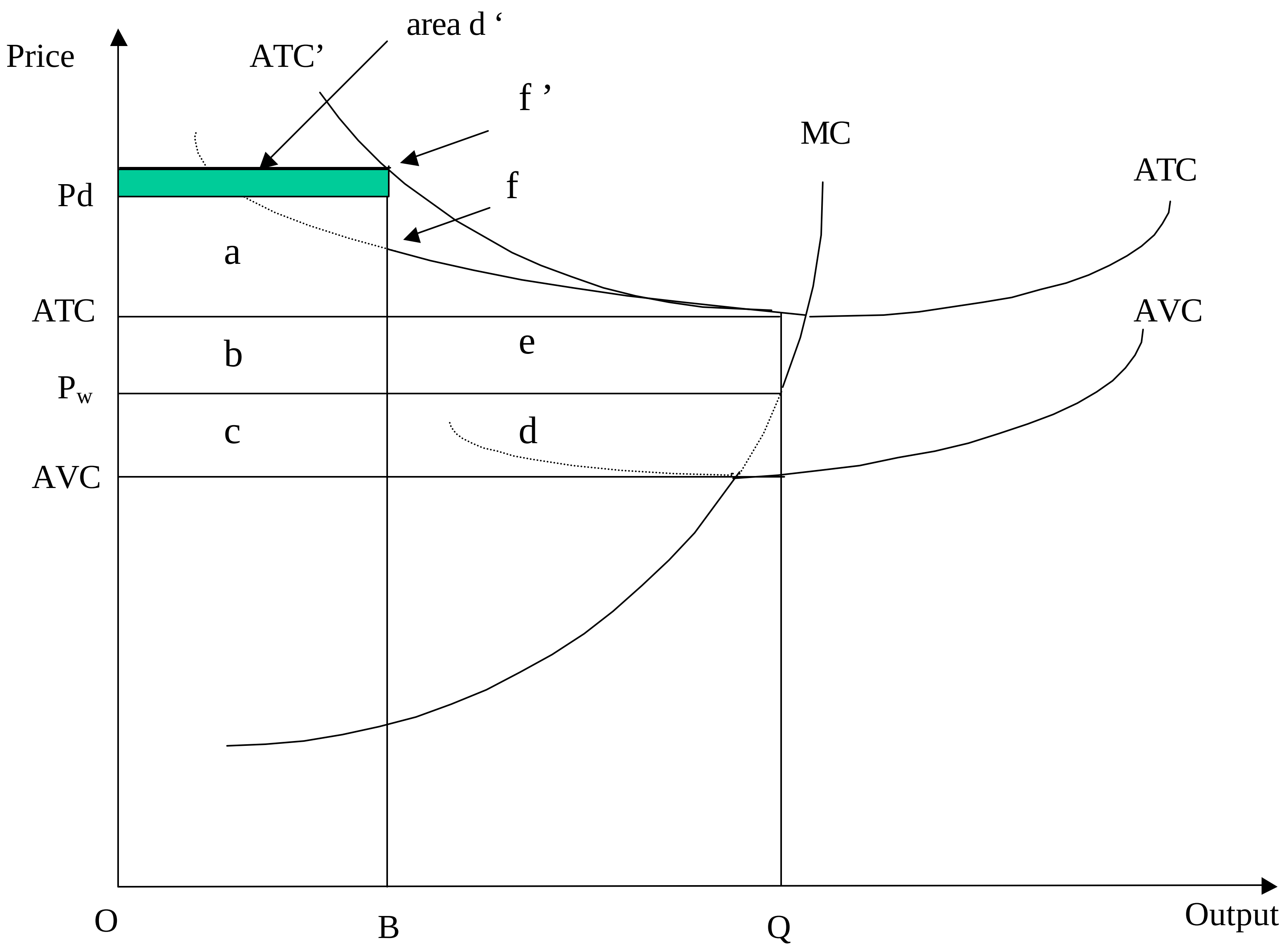


Figure 3: Fixed Costs and Output Effects of Losing on Exports with Direct Income Payments

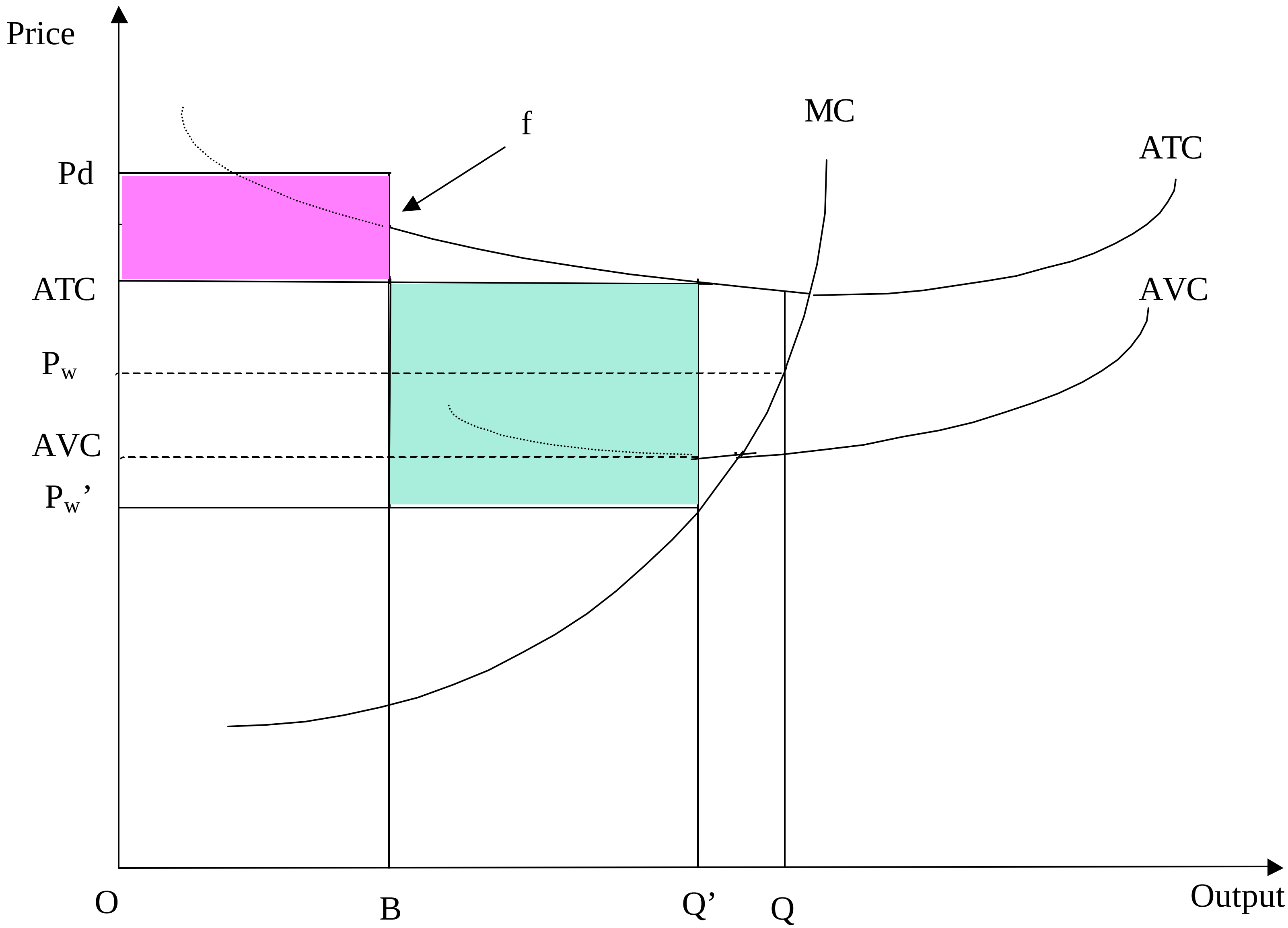


Figure 4

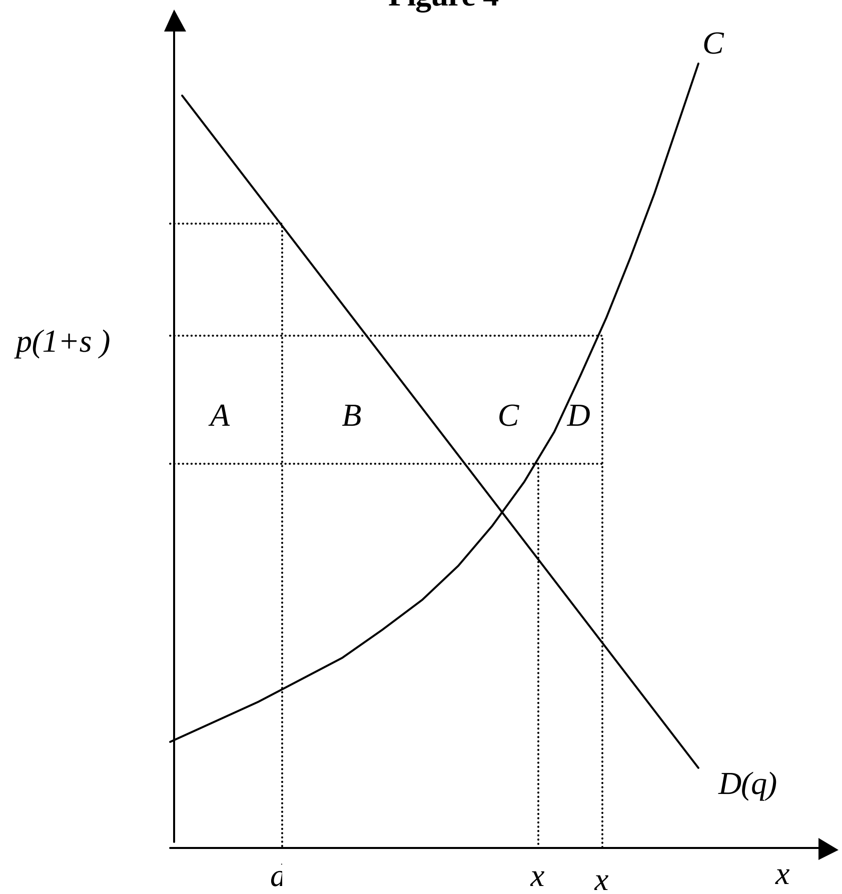


Table 1: Direct Government Payments (all major field crops in mil. $)

	1997	1998	1999P	2000F
Total Direct payments	8,070	12,225	22,704	17,190
AMTA	6,120	6,001	5,109	4,924
Loan Deficiency	na	1,792	6,874	7,866
CRP and other	1,950	1,623	1,989	1,966
Emergency Assistance	0	2,809	8,732	2,434

P = preliminary, F = forecast
Source: Agricultural Income and Finance/AIS-73/December 1999

Table 2: Fixed *versus* Variable Costs and Government Payments by Farm Size (sales class) for Wheat

1998	All wheat farms	> $500,000	$250,000 to $499,999	$100,000 to $249,999	$50,000 to $99,999	< $50,000
# of farms	43,739	1,089	2,463	8,045	11,131	21,008
Gross Cash Income	91,770	640,286	327,701	159,699	71,206	20,560
Government Payments	19,522	83,097	66,859	37,142	18,560	4,438
Average AMTA Payment	10,083	44,815	31,473	18,991	9,544	2,649
Average LDP Payment	4,111	*25,136	17,257	7,111	3,477	667
Less: Cash Expenses	74,540	493,267	231,215	124,293	61,985	22,066
Variable	53,154	369,791	163,819	86,942	45,105	15,145
Fixed	21,386	124,476	67,396	37,350	16,880	6,922
Equals: Net Cash Farm Income	17,230	147,018	96,487	35,406	9,220	-1,506
Net Farm Income	15,752	72,799	77,330	36,592	12,047	-442

*indicates that CV is greater than 25 and less than or equal to 50.

Table 3: U.S. Wheat Policy

	1998	**1999**
Loan Rate	2.58	2.58
Market Price	2.65	2.55
Base Acres (Mil. acres)	78.9	79.1
Cost of Production (mil. $)	11214.6	10551.5
Cost of Production ($/acre)	170.4	168.0
Variable ($/acre)	67.6	62.3
Fixed Costs ($/acre)	102.8	105.6
Acres Planted (Mil. acres)	65.8	62.8
LDPs + MLGs (mil. $)	476.5	917.2
LDPs + MLGs (mil. bushels)	1641.7	1971.1
AMTA + emergency aid (mil. $)	2301	2966
Payment Yield (bushels/acre)	34.5	34.5
Production (mil. bushels)	2547.3	2302.4
Exports (million bushels)	1041.7	1099.7

Table 4: U.S. Peanut Policy

	1998	**1999**
National Quota (Mil. lbs)	2334.0	2360.0
Production (Mil. lbs)	3963.4	3870.2
Exports (Mil. lbs)	561.0	800 (forecast)
Acres planted (1000 acres)	1521.0	1533.0
Yield (lbs)	2702.0	2711.0
Prices		
Quota (cents/lb)	39.8	39.8
Average price (cents/lb)	28.0	25.6
Gross Value of Production ($ Million)	1125.9	991.8
Total Costs ($/acre planted)	742.1	na
Operating Costs ($/acre planted)	328.7	na
Allocated Overhead ($/acre planted)	413.4	na

Table 5: Wheat Simulations

1998	All wheat farms	> $500,000	$250,000 to 499,999	$100,000 to 249,999	$50,000 to 99,999	< $50,000
# of farms	43,739	1,089	2,463	8,045	11,131	21,008
Output (mil. Bu.)	2,547.30	517.42	441.18	929.57	405.58	251.94
Output (Mil bu. per farm)		0.4751	0.1791	0.1155	0.0364	0.012
Computed output without LDP (Mil. bu)	2,281.88	466.04	408.7	848.37	355.35	203.41
Computed output without LDP (Mil. bu. per farm)		0.428	0.1659	0.1055	0.0319	0.0097

Table 6: Direct Income Payment and the Possibility of Exit

	Status-quo 1998	Removal of LDP (no exit)	Removal of LDP	Removal of AMTA	Removal of AMTA and LDP
% of farms with negative profits	--	--	25.99	28.38	29.47
# of farms with negative profits	--	--	11368	12411	12890
Computed Output (Mil. bu)	2,547.30	2,281.88	2171.81	2396.84	2157.05
% Reduction in Output		10.42	14.74	5.91	15.32
Computed Exports (Mil. bu)	1,505.60	1,041.70	666.21	891.24	651.47
% Reduction in Exports		30.81	55.75	40.80	56.73

Table 7: The Costs of Direct Income Payment

1998	All wheat farms	> $500,000	$250,000 to 499,999	$100,000 to 249,999	$50,000 to 99,999	< $50,000
Computed LDP payment ($ per farm)	--	90,275	34,033	21,954	6,923	2,279
Computed profits without LDP and AMTA	--	307,620	130,936	77,473	11,088	-827
Computed profits without LDP	--	352,435	162,409	96,464	20,632	1,821
Computed profits without AMTA	--	393,392	163,717	98,466	17,579	1,226
Increase in variable profits with LDP ($ per farm)		--	32781	20993	6490	2054
Deadweight loss ($ per farm)	--	4,503	1,252	961	433	225
Deadweight loss ($)	-25,265,211	4903767	3083676	7731245	4819723	4726800

References

Bhagwati, J. N., 1971. "The Generalized Theory of Distortions and Welfare", in J.N. Bhagwati, R. W. Jones, R. Mundell and J. Vanek (eds.) Trade, Balance of Payments and Growth: Papers in International Economics in Honor of Charles P. Kindleberger (North Holland: Amsterdam).

Collins, K. and J. Vertrees. 1988. "Decoupling and U.S. Farm Policy Reform," *Canadian Journal of Agricultural Economics* 36: 733-745.

de Gorter, H., and Y. Tsur. 1995. Supply and Welfare Effects of Income Stabilization Programs: NISA versus NTSP. Report to Policy Branch, Industry Performance and Analysis Directorate, Agriculture and Agri-Food Canada, Ottawa.

Hennessy, D. A. 1998. "The Production Effects of Agricultural Income Support Policies under Uncertainty," *American Journal of Agricultural Economics* 80: 46-57.

Moschini, G. and P. Sckokai. 1994. "Efficiency of Decoupled Farm Programs Under Distortionary Taxation," *American Journal of Agricultural Economics* 76: 362-370.

Roberts, I. M. 1997. "Australia and the Next Multilateral Trade Negotiations for Agriculture". ABARE Research Report 97.6, Canberra.

Skees, J. R. 1999 "Policy Implications of Income Insurance: Lessons Learned from the US and Canada" forthcoming in *The European Journal of Agricultural Economics*.