Supply, Land Quality, and Policy

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Abstract
Recent reforms of the EC grain sector justify renewed interest in the supply analysis of producer policies that include a subsidy and a land reduction requirement. Some supply analysis accounts for simultaneous land control and producer payment (Houck and Ryan, Gallagher). However, econometric methods of supply analysis have limited usefulness when major policy changes occur (Weaver). Major changes have indeed occurred in Europe, 1. CAP reform, introducing producer subsidies, low ?? price and set-aside. 2. Transition from central planning. But land quality is an important dimension of producer’s participation decisions (Brooks et al.). And the implications of producers with marginal land on market supply still require discussion. The potential for domestic supply distortions and price stability are relevant if trade agreements include such policies.

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Recent reforms of the EC grain sector justify renewed interest in the supply analysis of producer policies that include a subsidy and a land reduction requirement. Some supply analysis accounts for simultaneous land control and producer payment (Houck and Ryan, Gallagher). However, econometric methods of supply analysis have limited usefulness when major policy changes occur (Weaver). Major changes have indeed occurred in Europe.

1. CAP reform, introducing producer subsidies, low ?? price and set-aside.
2. Transition from central planning.

But land quality is an important dimension of producer's participation decisions (Brooks et al.). And the implications of producers with marginal land on market supply still require discussion. The potential for domestic supply distortions and price stability are relevant if trade agreements include such policies.

The supply analysis of this paper accounts for the subsidy and quota aspects of the policy when producers have similar implements of production but different land qualities. The model is static but straightforward in its data requirements. Thus, the circumstances under which supply will contract/expand and become more or less elastic in comparison to the market are identified.

Supply in the Free Market

Producers could have similar costs per acre because they use similar machinery, chemical treatments, and harvesting techniques. However, yield would still vary across firms due to different land qualities. These assumptions are useful first approximations.
Then profit maximizing firms would enter when revenues equal variable costs. Thus, the break-even point that defines entry for firm i's land is \( P Y_i = C \), where \( P \) is the product price, \( Y_i \) is the yield for firm i, and \( C \) is the cost per acre. Now suppose that farm's yields are uniformly distributed between an upper limit \( (y_u) \) and a lower limit \( (y_l) \). Then the yield density function is \( f(y) = \frac{1}{y_u - y_l} \).

The cumulative density function for price that combines the yield distribution and the land-use decision is the area response function, expressed as a percentage of the total land in the country:

\[ F(P) = \frac{[y_u - C/P]/[y_u - y_l]}{y_u - y_l}, \text{ for } P_1 < P < P_u. \]

The price bounds are defined by the entry points for the best land, \( P_1 = C/y_u \), and the poorest land, \( P_u = C/y_l \).

Output is the product of acreage and average yield for all the land in production:

\[ Q = F(P) E(y). \]

In turn, the mean yield for the land that is used is

\[ E(y) = \int_{y_l}^{y_u} \frac{y}{y_u - y} dy = \frac{1}{2} \left( y_u + y_l \right) = \frac{1}{2} \left( y_u + C/P \right) \]

when the quality distribution of yields is uniform and the yield for the marginal land unit is written in terms of the entry price. Then the free market supply response is

\[ Q_m = \frac{y_u^2 - \left( \frac{C}{P} \right)^2}{2(y_u - y_l)}. \]

**Participation Decisions**

Setaside programs combine elements of a producer subsidy with a restriction on input use. Specifically, a fixed subsidy, \( s \), is paid on each unit of output but producers must
reduce land use from \( L_1^* \) to \( \rho L_1^* \).

Often, the subsidy and the setaside requirement combine for an incentive to reduce production. Consider the break even point for a profitable firm. Profits are the same with participation and full production when \([(P+s)-P]y_i\rho L_i^* = (Py_i-C) (1-\rho) L_i^* \), or when area A equals area D in figure 1a. Alternatively, the producer will participate and reduce land use when costs per bushel exceed the market price less a correction for the subsidy: \( C/y_i > P-s[\rho/(1-\rho)] \).

But high-cost firms, those with low yields, could find that production is profitable when the firm would have shut down otherwise. The firm will produce with the amount of land allowed in the program when \([(P+s)y_i -C]\rho L_i^* > 0 \), or when area A in figure 1b is positive. Equivalently, the market price plus the subsidy must exceed unit costs \( P + s > C/y_i \) before production will occur.

**Effects on Market Supply**

The effects of participation decisions by high and low cost producers can be determined from the area response function, \( F(P) \), that depicts entry. The aggregation problem is shown in figure 2. If the market price had been \( P \) before the program, area would have been \( A_f \). Afterwards, some high-cost land that would not be profitable without the subsidy, \( A_m - A_f \), is used but at reduced amounts that satisfy the setaside requirement. In contrast, intermediate-cost land, \( A_f - A_n \), is reduced to satisfy the setaside requirement. Further, some low-cost land, \( A_n \), remains at full utilization when subsidies are moderate and set-aside requirements are high.

However, there is a point where all low-cost land is placed in the set-aside program.
This occurs when \( P_t = P - s \frac{\rho}{1 - \rho} \), or when the lower horizontal line in figure 2 falls to the entry price, \( P_t \). Beyond this point, high subsidies and moderate setaside requirements cannot reduce area but can distribute additional income to low-cost producers.

Area and yield response functions for participant and non-participants are summarized below:

<table>
<thead>
<tr>
<th>Program Decision (cost range)</th>
<th>Area, percent ((0-1)) of base</th>
<th>Yield</th>
</tr>
</thead>
<tbody>
<tr>
<td>non-participant ((C/y_t &lt; P^p))</td>
<td>( A_n = F(P_b) )</td>
<td>( y_n = \frac{1}{2} [y_u + C/P_b] )</td>
</tr>
<tr>
<td>participant ((P_0 &lt; C/y_t &lt; P + s))</td>
<td>( A_p = [F(P + s) - F(P_b)]\rho )</td>
<td>( y_p = \frac{1}{2} \left[ -\frac{C}{P + s} + \frac{C}{P_b} \right] )</td>
</tr>
</tbody>
</table>

\( P_b = \max [P_1, P - s - \frac{P}{1 - \rho}] \)

Combining area and yield components, \( Q = A_n Y_n + A_p Y_p \), gives the supply response function:

\[
Q_s = \frac{y_u^2 - (1 - \rho) (C/P_b)^2 - \rho [C/(P + s)]^2}{2(y_u - y_p)} .
\]

Beyond the point where the lowest-cost producers enter the program, this function reduces to:

\[
Q_s = \frac{\rho \left[ y_u^2 - \left( \frac{C}{P + s} \right)^2 \right]}{2(y_u - y_p)} .
\]

A comparison of supply response with and without the program suggests that supply under the program can be greater or less than the unregulated market supply. Unfortunately,
no general rules of thumb are apparent. Consequently, it is best to continue the discussion with an example.

**An Example**

Consider the EC grain sector. Reforms included a reduction in the domestic intervention price to \( P = 100 \) ecu/ton, a producer subsidy of \( s = 45 \) ecu/ton, and a fifteen percent setaside requirement: \( \rho = 0.85 \). Also, Bureau et al. provide some grain cost estimates for EC countries. Taking French variable costs (intermediate inputs and labor) at 110 ecu/ton and using average yields from the 1984-6 period (6 mt/ha) gives a cost estimate at about \( C = 640 \) ecu/ha. Average state yields give an idea of yield dispersion; yields for individual EC countries ranged between \( Y_L = 1.5 \) for Portugal to \( Y_U = 8.0 \) for Ireland during the 1988-1990 period.

In this example, the high subsidy and moderate setaside exceed the amount needed to induce participation by the most efficient producers when the market clears at the intervention price. The combination of planting allowances and setaside requirements that just induce the producers with the best land to participate are shown below:

<table>
<thead>
<tr>
<th>( \rho )</th>
<th>( \rho/(1-\rho) )</th>
<th>( s = \frac{20}{\rho/(1-\rho)} )</th>
</tr>
</thead>
<tbody>
<tr>
<td>.7</td>
<td>2.333</td>
<td>8.57</td>
</tr>
<tr>
<td>.75</td>
<td>3.000</td>
<td>6.66</td>
</tr>
<tr>
<td>.8</td>
<td>4.000</td>
<td>5.00</td>
</tr>
<tr>
<td>.85</td>
<td>5.666</td>
<td>3.53</td>
</tr>
<tr>
<td>.9</td>
<td>9</td>
<td>2.22</td>
</tr>
<tr>
<td>.95</td>
<td>19</td>
<td>1.0</td>
</tr>
</tbody>
</table>
These restrictions were developed from the condition:

\[ P_i = P - s \frac{p}{1-p} \]

given that \( p = 100 \). Further, using the same condition to determine when the best land will be taken out of the program yields the minimum price \( p = 335 \text{ ecu/ton} \). Thus, the analysis should use the supply function with \( P_b = P_i \).

The supply response with the policy is compared to the unregulated market in the table below. At the intervention price, supply is considerably (60%) higher than the corresponding free market output. Further, supply distortions continue until prices rise to nearly 150 ecu/ton.

<table>
<thead>
<tr>
<th>Qg</th>
<th>Qm</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>37.0590</td>
<td>0.00000</td>
</tr>
<tr>
<td>3</td>
<td>40.7268</td>
<td>15.4986</td>
</tr>
<tr>
<td>5</td>
<td>43.6623</td>
<td>26.5846</td>
</tr>
<tr>
<td>7</td>
<td>46.0482</td>
<td>34.7870</td>
</tr>
<tr>
<td>9</td>
<td>48.0136</td>
<td>41.0256</td>
</tr>
<tr>
<td>11</td>
<td>49.6517</td>
<td>45.8807</td>
</tr>
<tr>
<td>13</td>
<td>51.0315</td>
<td>49.7331</td>
</tr>
<tr>
<td>15</td>
<td>52.2045</td>
<td>52.8410</td>
</tr>
<tr>
<td>17</td>
<td>53.2101</td>
<td>55.3846</td>
</tr>
<tr>
<td>19</td>
<td>54.0786</td>
<td>57.4927</td>
</tr>
<tr>
<td>21</td>
<td>54.8340</td>
<td>59.2593</td>
</tr>
<tr>
<td>23</td>
<td>55.4949</td>
<td>60.7543</td>
</tr>
<tr>
<td>25</td>
<td>56.0766</td>
<td>62.0308</td>
</tr>
</tbody>
</table>

**Conclusion**

The role of differing land quality on market supply under typical agricultural policies has been examined. More general investigations of the micro-level yield distribution or entry price schedule are clearly possible. But the proposed supply relationships do have modest data requirements. They may access the potential for supply distortion and price stability.
when limited experience with new policies precludes analysis with the usually econometric methods. Calculations for the EC grain sector suggest that the supply curve has shifted outward and become more inelastic for most plausible price levels.

References


