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"Government Target Price Intervention in Economies with Incomplete Markets: Welfare and Distribution." Robert Innes (University of California, Davis)

In a world of certainty, a government target price/deficiency payment program benefits producers, hurts consumers (as taxpayers) and causes a net welfare loss to society as a whole. This paper shows that when there is uncertainty and markets are incomplete, all of these conclusions can be reversed: producers can be worse off, consumers better off and society better off. In particular, these outcomes will occur for a range of target prices under conditions which characterize staple food markets.

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I. INTRODUCTION

The target price/deficiency payment program is among economists' favorite examples of costly government intervention in competitive markets. Dubbed the "Brannan Plan" after President Truman's Secretary of Agriculture, this program pays producers the difference between a given target price and the prevailing market price for their output. In a world of certainty and perfect competition, such an intervention benefits producers, hurts consumers (as taxpayers) and causes a net ("Harberger triangle") welfare loss. The object of the research presented here is to show that these conclusions do not extend to a stochastic production economy with incomplete markets. In the latter setting, the distributional and welfare implications of a Brannan Plan are reversed under a set of empirically tractable conditions; producers are made worse off, consumers better off, and society better off. Notably, the conditions under which these outcomes occur include producer risk aversion and low price and income elasticities of demand, all of which are characteristics of staple food markets in which target price programs are actually employed (e.g., markets for wheat, corn, and rice).

It is well known that when markets are incomplete, competitive equilibrium is not, in general, Pareto optimal (Borch 1962), even in a constrained sense (Newbery and Stiglitz 1982; Hart). This observation has spawned extensive literatures on the welfare effects of commodity price stabilization (e.g., Turnovsky, Helms, Wright, Campbell and Turnovsky, Newbery and Stiglitz 1981, 1982b) and optimal trade policy (e.g., Young and Anderson, Newbery and Stiglitz 1984; and Eaton and Grossman). However, to my knowledge, its relevance to the welfare effects of other simple policy measures, including the Brannan Plan and consumer price ceilings, is yet to be explored. The present research aims to begin this exploration in the context of a simple two-sector model analogous to those employed in many equilibrium analyses of resource allocation and welfare under uncertainty (e.g., Newbery and Stiglitz 1982a, 1982b; Diamond; Britto); specifically, stochastic production drives a closed equilibrium system in which consumers and producers have rational expectations and there are no markets for state-contingent claims. For agriculture, this inquiry is of particular interest not only because target price intervention is so extensive (e.g., see Womack et al.) but because the importance of output uncertainty and incomplete risk trading is empirically evident (e.g., see Barry, Nelson, and C.F.T.C.).

The suboptimality of competitive equilibrium in an incomplete market setting is due to differences in agents' marginal rates of substitution between income in alternate states of the world. Hence, any policy which induces an exchange of state-contingent income in the lens of mutual advantage is Pareto-improving (see Figure 1). The Brannan Plan generates state-contingent income transfers between consumers and producers via two mechanisms:

1. Positive supply response to the program causes market prices of the supported commodity to fall, increasing consumers' real income and, with some qualifications, reducing producer profits in states which are characterized by high price and, thus, no deficiency payments.
2. In low price states, the program transfers income from consumers (as taxpayers) to producers.

These observations suggest that with positive supply response, the Brannan Plan can be Pareto improving when an exchange of low-price-state-income (consumers to producers) for high-price-state-income (producers to consumers) is in the lens of mutually beneficial trade. In terms of Figure 1, this condition is equivalent to e, the competitive equilibrium allocation, lying at the southeast end of the mutual benefit region, as depicted. Further, this graphical condition can be translated into the following relationship between marginal rates of substitution:

$$MRS_{consumer} = \frac{V_{1Y}}{V_{2Y}} < \frac{U'_1}{U'_2} = MRS_{producer} \quad (1)$$

where V_{sY} and U'_s denote marginal utilities of income in state s for the consumer and producer, respectively. That a supply-increasing Brannan Plan can be welfare-improving when (1) is satisfied at the no-program equilibrium is formally confirmed below.

Moreover, it is verified that (1) will be satisfied at this equilibrium under the conditions stated earlier. Intuitively, price inelastic demand implies that producer profits are higher in state 2 (high price) than in state 1 (low price); hence, with risk aversion, the right-hand-side of (1) will be greater than one. Further, since price is higher in state 2, the consumer's "real" income will be lower in that state, suggesting that his marginal utility of income will be higher and the left-hand-side of (1) will be less than one; a low income elasticity of demand ensures this outcome.

The distributional effects described above also have intuitive explanations. Adverse effects on producers result from supply response. When price is random, a target price cuts a lefthand tail off the price distribution. In the absence of any other effects, this truncation leads to a profit distribution for any production choice which first order stochastically dominates the corresponding profit distribution with no target price. However, if the Brannan plan program induces a supply response, it does more than chop a tail off the price distribution; it also leads to shifts in the distribution. If producers are competitive, as assumed here, they do not consider effects on prices in choosing output. In fact, a companion paper (see my dissertation) finds conditions under which they respond to a target price by increasing output so much that the resulting price drop in the high-price state leaves them worse off than before. As observed elsewhere (e.g. Newbery and Stiglitz 1982b; and Just and Zilberman), such a divergence in the directional shifts of output and utility is made possible by a non-monotonic relationship between <u>marginal</u> and <u>total</u> utility.

Beneficial consumer effects are also attributable to supply response and the resulting fall in market prices. In the certainty case, consumers must pay for the single-state price drop via the tax mechanism and this cost always exceeds the benefits which they receive from lower price. However, when there is more than one state of nature, the target price may not always be effective; there may be states in which the market clearing price remains higher than the target level. In these states, consumers pay nothing in taxes for the support mechanism but benefit from the lower price which supply response produces. These "free" benefits can, under some circumstances, exceed the excess costs paid by consumers in the event of high output (low price).

The remainder of this paper formally derives the conditions under which the welfare effects described above occur. It then illustrates all of the foregoing conclusions (both welfare and distributional) with a numerical example which incorporates empirical estimates of key parameters and tests for sensitivities to variation in these coefficients. Interested readers should note that analytical derivation of distributional implications can be found in Chapter 2 of my dissertation.

II. THE MODEL

Consider a static two good economy in which the two goods are a food commodity (x) and a numeraire (y).

Production

Assume that there exists a representative (aggregate) farmer who can be characterized as follows:

1. Preferences are defined on profits and satisfy the rationality axioms of Von Neumann and Morgenstern. The representative farmer's utility can then be represented by an expected utility function, $EU(\tilde{\pi})$ where E denotes the expectation operator over states of nature, $\tilde{\pi}$ the state dependent profit and $U(\cdot)$ the ex-post utility function, assumed state independent and twice differentiable with $U' > 0$ and $U'' \leq 0$.
2. He has a production technology defined by a twice differentiable cost function $C(z)$ (where cost is measured in units of the numeraire) and an output function, $x = \tilde{\theta}z$, where z is the input choice which must be made before the state is revealed and

$\tilde{\theta}$ is a state-dependent output coefficient. Assume $C' > 0$, $C'' > 0$, and $E(\tilde{\theta}) = 1$.

3. The farmer is a price taker and has rational expectations in the sense that the price he expects in state s is the equilibrium price in that state.

Consumers

Assume that there exists a representative consumer whose indirect utility function is $V(P,Y)$, where P is the price of food, Y is aggregate consumer income and $V(\cdot)$ is a twice differentiable state-independent function. Assume $V_P < 0$, $V_Y > 0$, and $V_{YY} \leq 0$. Let this consumer also obey the standard rationality axioms of choice under uncertainty, so that his utility can be represented by $EV(\tilde{P},\tilde{Y})$. Further, suppose that in the absence of taxes to pay for deficiency transfers Y is constant across states. Finally, assume that consumers pay the full cost of the Brannan Plan via a lump sum (ex-post) tax.

General

Let there be perfectly symmetric information and equilibrium stability in the Walrasian sense. Further, to simplify the algebra, suppose that there are two equiprobable states and $\theta_1 > \theta_2$. Finally, since target price levels below the no-program competitive equilibrium price in state 1 (denoted P_1^{ce}) will not be effective in either state, only target prices larger than this level will be considered.

With this construction, farmer profits in state s are:

$$\pi_s = \max(P_s, P^*)\theta_s z - C(z) \tag{2}$$

where P_s is the market price of food prevailing in state s and P* is the target price. The farmer's utility maximization problem can therefore be written:

$$\max\ .5[U(P^*\theta_1 z - C(z)) + U(\max(P_2, P^*)\theta_2 z - C(z))] \tag{3}$$

with first order condition (assuming an interior solution):

$$.5[U'_1(P^*\theta_1 - C') + U'_2(\max(P_2,P^*)\theta_2 - C')] = 0 \tag{4}$$

where U'_s denotes the state s derivative. Clearly, the farmer's optimal z, z*, is a function of received prices in all states, $\{\max(P_s,P^*)\}$. Therefore, given rational farmer expectations, market prices are determined by the equilibrium conditions (using Roy's identity):

$$x^d(P_s,Y_s) \equiv -\frac{V_P(P_s,Y_s)}{V_Y(P_s,Y_s)} = \theta_s z^*(\{\max(P_s,P^*)\}),\ s = 1,2 \tag{5}$$

where

$$Y_s = Y - (P^* - \min(P_s,P^*))\theta_s z^*(\{\max(P_s,P^*)\})$$

and $x^d()$ denotes consumer demand, assumed downward sloping in price. Let $P_1(P^*)$ and $P_2(P^*)$ denote the solutions to (5), assumed existent, unique, continuous everywhere and differentiable at all points other than where $P^* = P_2(P^*)$.

The solution to (5) gives market prices as a function of the target price. Therefore, the equilibrium producer input choice can be represented as a function of P* alone:

$$z^{**}(P^*) \equiv z^*(\{\max(P_s(P^*),P^*)\}) \tag{6}$$

III. WELFARE

In this section, the following question is posed: Under what conditions can compensation be made so as to make everyone better off with a target price program?

To address this question, consumer and producer compensating variations (CS and PS, respectively) are defined as follows (where prices and outputs represent compensated equilibrium outcomes):

$$\sum_{s=1}^{2} .5[V(P_s(P^*),\ Y - (P^* - \min(P^*,P_s(P^*)))\theta_s z^{**}(P^*) - CS)] = \bar{V}^{ce} \tag{7a}$$

$$\sum_{s=1}^{2} .5[U(\max(P^*,P_s(P^*))\theta_s z^{**}(P^*) - C(z^{**}(P^*)) - PS)] = \bar{U}^{ce} \tag{7b}$$

where $\bar{V}^{ce}$ and $\bar{U}^{ce}$ denote competitive (no Brannan Plan) equilibrium utilities of the consumer and producer, respectively. Further, let $W \equiv CS + PS$ denote society's compensating variation.

Two cases must be distinguished in order to differentiate these expressions:

Case 1: $P^* < P_2$. Differentiating (7a) and (7b) with respect to P^*, solving for the change in CS and PS, and summing gives the change in society's compensating variation for a marginal increase in the target price:

$$\frac{dW}{dP^*} = \frac{dCS}{dP^*} + \frac{dPS}{dP^*} = .5[\theta_1 z^{**}(P^*) \left[\frac{U'_1}{E(U')} - \frac{V_{1Y}}{E(V_Y)}\right] + \theta_2 z^{**}(P^*) \left[\frac{U'_2}{E(U')} - \frac{V_{2Y}}{E(V_Y)}\right]\left[\frac{dP_2}{dP^*}\right] - \left[\frac{V_{1Y}}{E(V_Y)}\right] (P^* - P_1)\theta_1 \left[\frac{dz^{**}}{dP^*}\right]] \tag{8}$$

Case 2: $P^* < P_2$. Here the analog to equation (8) is:

$$\frac{dW}{dP^*} = \left[\frac{Cov(U',\theta)}{E(U')} - \frac{Cov(V_Y,\theta)}{E(V_Y)}\right] z^{**}(P^*) - E\left[\frac{V_Y}{E(V_Y)}(P^* - P)\theta \frac{dz^{**}}{dP^*}\right] \tag{9}$$

where Cov(.,.) denotes the covariance operator.

These equations imply the following proposition:

<u>Proposition 1</u>: If $dP_2/dP^* \leq 0$ at $P^* = P_1^{ce}$, then a sufficient condition for the existence of a welfare-improving target price is that (1) be satisfied at the no-program competitive equilibrium. (Note: P_1^{ce} denotes the no-program state 1 price.)

Proposition 1 formally confirms the intuitive speculation in the introduction. Incomplete markets imply a lens of mutually beneficial trade into which a compensated

Brannan Plan will push the economy provided it induces a decline in the second state-price and condition (1) is met.

To restate the conditions of Proposition 1 in terms of more familiar economic variables requires evaluation of the derivatives dz^{**}/dP^* and dP_2/dP^*. This evaluation leads to the following corollary, the key result of this section (see my dissertation for details):

Corollary 1.1: If (i) demand is price inelastic for $P \epsilon [P_1^{ce}, P_2^{ce}]$, (ii) farmers are strictly risk averse with non-increasing absolute risk aversion, and (iii) η (the income elasticity of demand) is approximately zero for $P \epsilon [P_1^{ce}, P_2^{ce}]$, $Y_s = Y$ (s=1,2), then a positive target price, $P^* > P_1^{ce}$, will be socially optimal.

It remains to show that these observations above can imply more than trivial effects. This is done by way of a numerical example in the next section.

IV. A Numerical Example

Suppose the farmer has a constant absolute risk aversion utility function, $U(\pi) = -e^{-\phi\pi}$, $\phi > 0$ and a constant elasticity cost function, $C(z) = z^{\delta}$, $\delta > 1$. Further, let the consumer indirect utility function take the form, $V(P,Y) = \frac{P^{1-\gamma}}{\gamma-1} + Y$, which implies constant price elasticity, zero income elasticity aggregate demand, $x^d(P,Y) = P^{-\gamma}$, $\gamma > 0$. Considering empirical evidence, the four parameters of this problem were varied as follows:

(1) ϕ. Extant empirical and theoretical research indicates that relative risk aversion coefficients are close to one, though the evidence is mixed (e.g., see Arrow, Antle, Binswanger). To test for sensitivities, this coefficient was approximately set at values between 1 and 5. In particular, the certainty competitive equilibrium was solved (given the other parameters), giving a profit level π^*. ϕ was then set so that $\phi\pi^* \epsilon \{1,2,3,4,5\}$.

(2) γ. Recent empirical evidence indicates that price elasticities of demand for staple food crops are close to .2 (Huang, Blanciforti et al.). For sensitivity testing, this parameter was varied from .2 to .9 (by increments of .1).

(3) δ. Two values of the cost elasticity were considered: 2 and 3.

(4) θ_2. (Recall that $\theta_1=2-\theta_2$.) The production coefficient was set at .7, .8, and .9.

In addition, the target price level was varied between the no-program equilibrium prices in the two states. In particular, the target price was set at a linear combination of these two prices, $P^* = (1-q)P_1^{ce} + qP_2^{ce}$, where q was varied between 0 and 1 by increments of .02.

Numerical Results

For space reasons, Table 1 presents only a few of the more important numerical outcomes. These and other results can be summarized as follows:

(1) Adverse Farmer Effects. Farmers can be substantially worse off with target prices either chosen to maximize consumer utility or chosen "optimally" for society. For example, when $\delta = 2$, $\gamma = .2$, $\theta_2 = .9$, and $\phi\pi^* = 1$, producers are willing to give up over 15 percent of their state 1 competitive equilibrium profit to avoid imposition of the socially optimal target price. Not surprisingly, this phenomenon depends crucially on certain parameter specifications (particularly the demand elasticity and risk aversion coefficient).

(2) Favorable Consumer Effects. Table 1 indicates that consumer gains from a Brannan Plan program can be tremendous. While these gains grow dramatically with production risk (θ_2), they are very large even with the lowest risk level examined. Further, these favorable effects were found to persist with very high target price levels.

(3) Distribution. Even when farmers are better off with a given target price, their gain can be small relative to profits and/or the consumer gain. When $\gamma = .2$, for example, the producer gain from the socially optimal target price is always small relative to the consumer benefit. When $\gamma = .8$, consumers tend to lose a little with target prices and farmers to gain a little. Neither case justifies the standard characterization of Brannan Plan programs as farm subsidies/bail-outs. In the former case, the most plausible for agriculture, these programs would be better characterized as consumer subsidies. In the latter case, the effects of supply response on farmer profits curtail the producers' utility gains.

(4) Tax Costs. Large consumer and social gains from a Brannan Plan program can be associated with large tax costs in state 1. For example, when $\gamma = .2$, $\phi\pi^* = 3$, $\delta = 2$, $\theta_2 = .8$, and the target price is set at the socially optimal level (EQU = SO), state 1 tax costs are 1.6076, while state 1 commodity expenditures are .4366 and welfare gains of the program are 2.5162.

(5) Pareto Superiority. There is a wide range of circumstances under which a Brannan Plan program leads to an allocation which is Pareto superior to competitive equilibrium, even in the absence of compensation. However, as γ rises, the range of target prices for which Pareto superiority holds in the absence of compensation narrows.

(6) Potential Pareto Superiority. Table 1 indicates that the social gains from target prices can be enormous. Not surprisingly, the key parameters effecting the magnitude of social gains are, in order of importance, the demand elasticity (negatively related) and the production risk (positively related). Note also that social gains persist over a wide range of target price levels, even when γ is at the high end of the range considered here.

In summary, the numerical analysis reveals that all of the effects discussed earlier can be large and can persist over a wide range of target price levels, particularly when the price elasticity of demand is low.

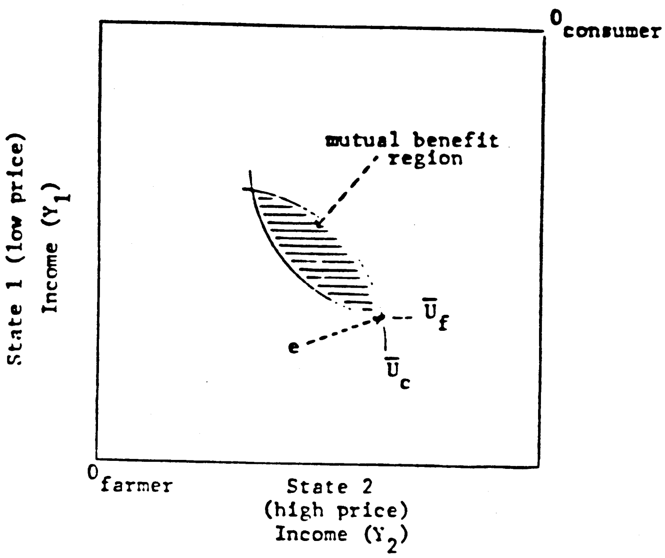
V. Summary and Conclusion

This paper has shown that under conditions characteristic of agriculture (i.e., incomplete markets, farmer risk aversion, and consumer demand which is characterized by low price and income elasticities), a target price/deficiency payment program can be used to induce equilibrium allocations which Pareto dominate competitive equilibrium. Further, in the absence of compensation, the distributional effects of such a program can be just the opposite of those implied by conventional thinking: farmers can be worse off and consumers/taxpayers better off. As the numerical example shows, all of these effects are of significant magnitude when parameters take on values which have been empirically estimated for staple food markets.

In conclusion, I should mention a number of research topics suggested by the foregoing research. Since the focus here is on specific policy measures in a simple, single period, closed economy setting, a full understanding of many policy contexts requires extension to international, intertemporal, multiple instrument, and political economies. In addition, an important question has been left in the background: why are there imcomplete markets? Without an explanation for market incompleteness, the feasibility and/or cost effectiveness of government policy measures are in doubt. Though the interventions proposed here do not violate conventional transactions costs or informational explanation for lacking markets, the concept of "optimal policy" is vacuous in the absence of a coherent treatment of this issue.

FIGURE 1

PURE EXCHANGE REPRESENTATION OF INCOMPLETE MARKETS



Legend: e = competitive (no-program) equilibrium allocation

$\overline{U}_f$ = farmer indifference curve for the utility generated by allocation e

$\overline{U}_c$ = consumer indifference curve for the utility generated by allocation e

COMPETITIVE EQUILIBRIUM (CE), EQUILIBRIUM WITH THE SOCIALLY OPTIMAL PRICE SUPPORT (SO), AND EQUILIBRIUM WITH THE CONSUMER OPTIMAL TARGET PRICE (CO)

δ	γ	θ_2	$\phi\pi^*$	EQU	P*	z	P_1	P_2	PS	CS	W
				CE	0.0	.8557	1.3531	3.6904	0.0	0.0	0.0
2	.2	.9	1	SO	1.6803	.9507	.7994	2.1803	-.0828	.4233	.3405
				CO	1.6336	.9458	.8205	2.2379	-.0874	.4254	.3380
				CE	0.0	.7899	1.3071	9.9259	0.0	0.0	0.0
2	.2	.8	1	SO	1.6519	1.0266	.3523	2.6757	-.1056	2.2491	2.1435
				CO	1.6519	1.0266	.3523	2.6757	-.1057	2.2491	2.1435
				CE	0.0	.8363	1.5178	4.1396	0.0	0.0	0.0
2	.2	.9	3	SO	1.7275	.9549	.7822	2.1333	.0321	.6642	.6963
				CO	1.7275	.9549	.7822	2.1333	.0321	.6642	.6963
				CE	0.0	.7910	1.3208	1.9731	0.0	0.0	0.0
2	.5	.9	1	SO	1.4643	.8177	1.2360	1.8464	.0306	-.0193	.0113
				CO	0.0	.7910	1.3208	1.9731	0.0	0.0	0.0

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