Butter mountains and wine lakes

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Abstract

One consequence of the EU's common agricultural policy was surplus: "butter mountains" and "wine lakes." This paper shows that it may be optimal for the government to stockpile agricultural products as part of an overall plan for income redistribution. If agricultural producers receive sufficient weight in the government's social welfare function then a policy of price supports combined with government purchases of the resulting surplus may be optimal.

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1 Introduction

In its heyday, Europe's common agricultural policy (CAP) led to huge stockpiles of agricultural products. Colorful terms like "butter mountains" and "wine lakes" were common. This policy appears wasteful. However, it may actually be optimal, given the policymakers' preferences and the constraints that they face. The idea is quite simple. Suppose agricultural producers receive much weight in the government's social welfare function. This could be due to political reasons or any other social objectives. In this setting, the government has an incentive to use its policy instruments to redistribute income in favor of this group. But there may be obstacles that deter direct redistribution. For instance, it is generally accepted that lump sum redistribution is not feasible. Also, the income tax is not suited for sector specific redistribution. So other policy tools must be used, and price supports are a candidate. The government can use taxes and subsidies to raise the relative price of agricultural products at the producer level. Presumably the government could also use its policy instruments to manipulate consumer prices in such a way that these markets just clear. But in a general equilibrium setting, any price distortion in one market can have feedback effects in other markets. Hence, there is no a priori reason to believe that the optimal policy is one in which all markets just clear. It may be optimal to allow the private sector to produce more than it consumes, with the government stepping in to purchase the surplus and simply store it in stockpiles. Ideally, one would like to see these stockpiles put to good use. However, it may be impossible to achieve this through the price system because of adverse general equilibrium effects. Of course, there may be other policies that can effectively put the stockpiles to use (e.g., price discrimination through food vouchers for the poor, or dumping the surplus on international markets), but that is beyond the focus of this paper. Here, the goal is simply to demonstrate a set of circumstances under which stockpiles could be optimal.

Section 2 presents a simple general equilibrium example that illustrates the possibility described above. The key feature is the following. The good in excess supply (agricultural output) is a consumption complement, at the aggregate level, of other goods for which the market just clears. Under this assumption, consider what happens if the consumer price of the agricultural product is lowered in an effort to stimulate demand, thus reducing the size of the stockpile: The demand for the complements also increases. This causes demand to exceed supply for the complements, which cannot be an equilibrium. It may be possible to restore equilibrium by adjusting other prices. But if the interactions between markets are sufficiently complex, then all of these new equilibria may have lower social welfare than the original equilibrium. Under this scenario, the stockpile is optimal.

2 Example

There are four commodities: two types of specialized labor/leisure and two final goods. Type ℓ labor is used to produce good x. This is the agricultural sector. Type n labor is used to produce good y. This is the manufacturing sector. Intermediate goods are not included in order to keep the analysis simple. Thus goods x and y are consumed directly by households.

Production is organized as follows. Agricultural production is carried out by a single self-employed farmer. Manufacturing, on the other hand, is carried out by one private sector firm that has constant returns to its only input, factory labor. Thus there are no profits to be distributed to households. Labor is completely specialized. That is, the farmer cannot provide labor for manufacturing, and factory workers cannot work the land. This could be justified through a comparative advantage argument. The assumption that all agricultural output is generated by household production is clearly unrealistic. However, a model with both corporate farms and household farms would add little to the story.

There are only two consumers. One is the farmer. The other is a factory worker.

Consumer 1 (self-employed farmer) has the following utility function:

$$U_1(\ell_1, x_1, y_1) = \theta_1 \log \ell_1 + \log(\min\{x_1, y_1\})$$

which is written here as a function of consumption levels (not net demands). The assumption that x and y are perfect complements is analytically convenient. The endowment is $\bar{L}_1$ units of labor/leisure. The technology for producing agricultural output is as follows. One unit of labor yields one unit of good x. Let q_x and q_y denote consumer prices, and let p_x be the producer price for food. (Then $q_x - p_x =$ tax, or subsidy if negative.) The budget constraint is

$$q_x x_1 + q_y y_1 \leq p_x(\bar{L}_1 - \ell_1).$$

This forces the farmer to sell all output through the market. This turns out to be an innocuous restriction since production of x will be subsidized ($p_x > q_x$). Thus, the farmer would rather sell all output then buy x_1 of it back, rather than bypass the market and eat x_1 directly. The utility maximizing consumption levels are

$$\ell_1 = \frac{\theta_1}{1+\theta_1}\bar{L}_1, \quad x_1 = y_1 = \frac{1}{1+\theta_1}\frac{p_x}{q_x + q_y}\bar{L}_1$$

and the aggregate supply of food is $X = \bar{L}_1 - \ell_1 = \bar{L}_1/(1+\theta_1)$. Indirect utility is $V_1 = \log[p_x/(q_x+q_y)] +$ constant.

Consumer 2 (factory worker) has the following utility function:

$$U_2(n_2, x_2, y_2) = \theta_2 \log(\min\{n_2, x_2\}) + \log y_2.$$

The endowment is $\bar{N}_2$ units of labor/leisure. The budget constraint is

$$q_x x_2 + q_y y_2 \leq q_n(\bar{N}_2 - n_2).$$

The utility maximizing consumption levels are

$$n_2 = x_2 = \frac{\theta_2}{1+\theta_2}\,\frac{q_n}{q_n+q_x}\bar{N}_2, \quad y_2 = \frac{1}{1+\theta_2}\,\frac{q_n}{q_y}\bar{N}_2$$

and the aggregate supply of factory labor is $\bar{N}_2 - n_2$. Indirect utility is $V_2 = \theta_2 \log[q_n/(q_n+q_x)] + \log(q_n/q_y) +$ constant.

The manufacturing firm can transform factory labor one-for-one into good y. Thus the production constraint is $Y \leq \bar{N}_2 - n_2$. The direct social welfare function is $W = \alpha U_1 + U_2$.

The government solves an optimal taxation problem (e.g., Auerbach, 1985; Diamond and Mirrlees, 1971; and Mirrlees, 1986). Indirect social welfare is maximized subject to the weak inequalities for market clearing. By Walras' Law, the government's budget constraint is satisfied with equality. That is, the cost of buying the surplus equals the net revenue from taxation:

$$p_x(X - x_1 - x_2) = (p_n - q_n)(\bar{N}_2 - n_2) + (q_x - p_x)(x_1 + x_2) + (q_y - p_y)(y_1 + y_2).$$

This holds because both consumers satisfy their budget constraints with equality, the market for good y just clears, and the manufacturing firm earns zero profits.

If the level of agricultural production leads to excess supply, the market clearing condition for good x will not bind. Then the government's problem is to choose p_x, q_x, q_y, and q_n to maximize $\alpha V_1 + V_2$ subject to $y_1 + y_2 \leq Y \leq \bar{N}_2 - n_2$ where the consumption quantities are given by the solutions to the consumers' problems. Given the structure of the example — in particular, the perfect complements and the constant solution for ℓ_1 — the government's problem can be written

$$\begin{aligned} &\text{maximize} \quad \alpha U_1 + U_2 = \alpha \log y_1 + \theta_2 \log n_2 + \log y_2 + \text{constant} \\ &\text{subject to} \quad y_1 + y_2 + n_2 \leq \bar{N}_2 \end{aligned}$$

where the choice variables are now the quantities y_1, y_2, and n_2. The prices that support the optimal allocation can then be inferred by inverting the consumers' demand functions.[1] The solution is

$$y_1 = x_1 = \frac{\alpha}{1+\alpha+\theta_2}\bar{N}_2, \quad n_2 = x_2 = \frac{\theta_2}{1+\alpha+\theta_2}\bar{N}_2, \quad y_2 = \frac{1}{1+\alpha+\theta_2}\bar{N}_2.$$

(Recall that the perfect complements satisfy $y_1 = x_1$ and $n_2 = x_2$.) And from the farmer's problem, $\ell_1 = \theta_1 \bar{L}_1/(1+\theta_1)$. With the normalization $q_x = 1$, the optimal prices are

$$p_x = (1+\theta_1)\left(1 + \frac{\alpha}{1+\alpha+\theta_2}\right)\frac{\bar{N}_2}{\bar{L}_1}, \quad q_n = \frac{1+\theta_2}{\alpha}, \quad q_y = \frac{1+\alpha+\theta_2}{\alpha}.$$

Finally, we must confirm that this optimum indeed has excess supply in the market for good x, i.e., $x_1 + x_2 < X = \bar{L}_1 - \ell_1$. Also, agricultural production must be subsidized: $p_x > q_x$. After substitution, these

[1] This is just a change of variables. Rather than optimizing over the four nominal variables p_x, q_x, q_y, and q_n, one can optimize over the three real variables $y_1 = (1+\theta_1)^{-1}\bar{L}_1 p_x/(q_x+q_y)$, $y_2 = (1+\theta_2)^{-1}\bar{N}_2 q_n/q_y$, and $n_2 = \theta_2(1+\theta_2)^{-1}\bar{N}_2 q_n/(q_n+q_x)$.

inequalities lead to the following parameter restrictions:

$$(1+\theta_1)\left(1-\frac{1}{1+\alpha+\theta_2}\right) < \frac{\bar{L}_1}{\bar{N}_2} < (1+\theta_1)\left(1+\frac{\alpha}{1+\alpha+\theta_2}\right).$$

It follows that there is an open set of parameter values for which agricultural stockpiles are optimal. In particular, if the consumers' parameters satisfy

$$1+\theta_1 < \frac{\bar{L}_1}{\bar{N}_2} < 2(1+\theta_1),$$

then stockpiles are optimal for all sufficiently large values of α, i.e., for all sufficiently large welfare weights on the farmer.

3 Discussion

The example is designed to be simple, but there is nothing pathological about it. For instance, it does not violate the Diamond–Mirrlees (1971) production efficiency theorem. Production here is efficient; distribution is not so efficient. As a general matter, the optimal tax problem will select the most desirable allocation from among those that are both productively feasible and market feasible (i.e., attainable through the price system). The Diamond–Mirrlees theorem tells us that the optimum must lie on the frontier of the production possibilities set. There are no further restrictions that tell us where on the frontier we will end up. Nor is there any requirement that the production point must coincide with the consumption point. In the example, the gap between the production and consumption of good x allows us to achieve a higher level of social welfare. If we were to require this market to just clear, welfare would necessarily be lower (for the range of parameter values indicated above).

One might object that the example's optimal tax problem has a producer price, p_x, among the choice variables. Perhaps this drives the result? Standard optimal tax problems contain only consumer prices. However, such an objection is not warranted. We can easily convert the example into the standard form and get exactly the same result, optimal excess supply. The interpretation would be different but the analysis would remain as above. Suppose the self-employed farmer is split into two separate economic entities: a farm worker (consumer) and a farm (firm). The farm worker now earns labor income at the wage rate q_ℓ, while the farm uses the one-for-one technology to transform farm labor into agricultural output. So q_ℓ replaces p_x in consumer 1's problem, but all else remains the same. The drawback is that the example no longer tells a story about agricultural price supports.

Consider the general form of an optimal tax problem. This may help shed some light on the example. The government's choice variable is a vector of prices q, and perhaps also a head tax/subsidy T. The objective is to maximize an indirect social welfare function $W(q,T)$ subject to a number of market clearing conditions. If those conditions can be written as $F_1(q,T) \leq 0, \ldots, F_n(q,T) \leq 0$ with $n > 1$, then the

Diamond–Mirrlees theorem tells us that at least one of these inequalities must bind; it does not tell us that all of them must bind. And indeed, this is what happens in the example. More generally, whenever there are specialized factors of production, it may be possible to express the market clearing conditions in this way with $n > 1$. This opens up the possibility for optimal excess supply. Whether the possibility becomes a reality depends on both private preferences (demand functions) and social preferences. The example's demand complementarities and social welfare weights provide a combination that yields optimal stockpiles. Other combinations are surely possible.[2] A general set of conditions awaits future research.

[2] Guesnerie (1995, section 5.2.2) demonstrates that as the social welfare weights vary over all possible values, the set of all optimal tax equilibria becomes large. If there are sufficiently many heterogeneous households, this set will generically be a manifold with the same dimension as the frontier of the aggregate production possibilities set. If we also allow private preferences to vary, this set will become an even larger part of the production frontier — larger than the set where all n of the constraints $F_i(q, T) \leq 0$ bind.

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