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Market Effects of In-Kind Subsidies

by

James P. Houck*

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*James P. Houck is a Professor, Department of Agricultural and Applied Economics, University of Minnesota.

Correspondence or requests for additional copies of this paper should be addressed to:

Dr. James P. Houck
Department of Ag & Applied Economics
1994 Buford Avenue
University of Minnesota
St. Paul, MN 55108

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(ABSTRACT)

MARKET EFFECTS OF IN-KIND SUBSIDIES

In-kind price subsidies are a new and important feature of U.S. agricultural policy. Yet the market effects of such subsidies have not been widely discussed in the professional literature even though they differ importantly from similar cash subsidies. This paper examines in-kind subsidies with simple, static demand and supply functions.

In-kind price subsidies push down prices to favored buyers and increase total sales relative to no subsidy or to an equivalent cash subsidy. Inventory holdings by the subsidizing authority are diminished. However, the effects of an in-kind subsidy upon prices received by sellers and commercial sales volume (net of stock disposals) are problematic, depending upon the price elasticity of demand in the subsidized market. If the demand, including retaliation by other sellers, is price elastic, then an in-kind subsidy will increase prices received by sellers and commercial sales volume. But if the demand is inelastic, then sellers' prices and commercial sales volume will drop relative to a no-subsidy situation or to an equivalent cash subsidy. These conclusions do not depend upon the methods by which the scheme is administered.

MARKET EFFECTS OF IN-KIND SUBSIDIES

In-kind subsidies and payments are now an important and fascinating part of the U.S. agricultural policy scene. In recent years, the government has used its sizeable inventory of grain and other commodities as the means of payment for some financial obligations created under the Food Security Act of 1985 as well as previous legislation.

Setting aside administrative complexities and day-to-day operational details, the basic idea of in-kind payments is that quantities of surplus commodities are placed on commercial markets so that the sales proceeds can cover financial commitments or achieve price targets of the government. The usual practice is for the government to use commodities instead of money to meet some of its obligations, leaving it up to the individual recipients to make subsequent dispositions in both domestic and foreign markets. The fundamental economics of markets affected by such in-kind dispositions has not been illuminated in the literature. That is the central goal of this paper. In particular, the use of in-kind payments to finance price subsidies will be probed by means of simple, straightforward, analytical techniques. Parallels with the current Export Enhancement Program (EEP) of the United States will be evident to many readers, but this paper's analysis is put forward in a more general market context.

Payment-in-kind programs have received much attention in popular, management-oriented publications of U.S. agriculture but much less consideration in the professional literature of agricultural economics. Articles by Kennedy, Kuchler and Vroomen, and the U.S. Department of Agriculture (August 1987a) are examples of the latter. Operational details, administrative objectives, and data on such programs are available in a few, mainly official, publications such as those by Mendelowitz, U.S.

Department of Agriculture (August 1987b), U.S. General Accounting Office, and U.S. Senate Committee on Agriculture, Forestry, and Trade. In addition, Houck has published a largely geometrical analysis of a specific type of in-kind export subsidy program, one which turns out to be a special case of the more general approach developed in the following pages.

This approach is first to describe a simple, static, linear market demand and supply system for a hypothetical commodity, next to establish a free market benchmark solution, and then to introduce both cash and in-kind subsidy interventions by a central authority so that their economic implications can be highlighted and compared. In-kind subsidies in both a single market and in a segmented, targeted market are examined. Production, consumption, price, and revenue results are emphasized, but welfare analyses are sidestepped. By keeping the approach relatively uncomplicated and abstract, the economic effects of in-kind payment schemes can be seen quite clearly.

Free Market Benchmark

Before introducing either in-kind or cash subsidies, it will be useful to set down a very elementary free market situation. The following four-equation linear system describes a simple competitive market for a hypothetical commodity:

$$\begin{aligned} QD &= a - bPD \\ (1) \quad QS &= c + dPS \end{aligned}$$

$$\begin{aligned} PD &= PS = PE \\ (2) \quad QD &= QS = QE \end{aligned}$$

where QD and QS are quantities demanded and supplied respectively, PD and PS are demand and supply prices, PE and QE are equilibrium prices and quantities of the ordinary kind, the parameters (a, b, c, and d) are positive values, and the negative slope of the demand function is reflected by the sign on b.

Solving this system for PE and QE yields the following, well-known results:

$$\begin{aligned} PE &= (a - c)/(b + d) \\ (3) \quad QE &= (ad - bc)/(b + d) \end{aligned}$$

Cash Subsidies and Inventory Disposal

In order to examine the economics of in-kind subsidies, it makes sense first to look briefly at how cash subsidies and/or inventory disposals affect the benchmark solution. A cash subsidy on sales is a per unit payment made by the government or an official agency usually to sellers as individual exchanges are negotiated. It becomes a wedge between total per unit values received by sellers and lower prices paid by buyers.

Inventory disposals in this context are sales into the market made by the public authority using stocks already in hand. We assume that these stocks were accumulated previously. The benchmark demand and supply equations of (1) remain the same, but with cash subsidies and inventory disposals, the equilibrium conditions of (2) are replaced by:

$$\begin{aligned} PS &= PD + C \\ (4) \quad QD &= QS + I \end{aligned}$$

where C is the per unit subsidy value and I is the amount sold into the market by the central authority.

If the per unit subsidy value is established exogenously at C^* and inventory sales are similarly exogenous at I^* , then the equilibrium solutions can be written as follows:

$$(5) \quad PD = PE - [d/(b+d)] [C^* + I^*/d]$$

$$(6) \quad PS = PE + [b/(b+d)] [C^* - I^*/b]$$

$$(7) \quad QD = QE + [bd/(b+d)] [C^* + I^*/d]$$

$$(8) \quad QS = QE + [bd/(b+d)] [C^* - I^*/b]$$

Equations (5) and (7) illustrate that, from the buyers' viewpoint, cash subsidies and disposals work together to lower prices paid and increase total quantities demanded relative to the benchmark values. Equations (6) and (8) indicate that, from the sellers' viewpoint, these interventions work at cross purposes. The cash subsidy, C^* , acts to raise PS and QS above the free market benchmark, while I^* acts to decrease PS and QS. (In this context, QS can be viewed as "commercial" sales, net of inventory disposal by the central authority.) Hence, prices received by sellers and commercial sales will rise if the positive effects of the subsidy (C^*) outweigh the negative effects of inventory sales (I^*). Or they will fall if the reverse is true. Of course, if either C^* or I^* is zero in equations (5) through (8), then the equilibrium results are unambiguous. In this particular analysis, it is assumed that the absolute size of the central authority's stockpile has no effect on prices or other variables, only its disposals and acquisitions. The results which follow would need to be modified if, for instance, the existence of a smaller central inventory caused prices to be higher than otherwise. Now let us consider an in-kind subsidy.

In-Kind Subsidy in a Single Market

An in-kind price subsidy scheme imposed on this market creates a special case of the subsidy/disposal results reflected in equations (5) through (8). Assume that, to operate such a scheme, the authorities give actual physical stocks of the commodity to traders as a "reward" for negotiating sales.¹ These stocks then can be sold by the traders to generate cash.

The process by which this intervention is conducted might take on numerous operational guises. For example, a per-unit subsidy value for all sales could be announced in money terms but actually paid in kind at some specified per unit value of the released inventory volume. Or in-kind premiums could be given based on the volume of negotiated sales -- "sell five tons, get one free." Or a set volume of the surplus commodity could be sold into the market by the central authority and those proceeds distributed to commercial sellers as a supply price enhancement. In any case, the equilibrium conditions of a demand-supply system featuring an in-kind subsidy resemble those in equations (4), but more is required. In particular, some systematic connection between in-kind inventory disposals and the resulting price subsidy is needed.

To provide this connection, let V be the per unit money value of the subsidy, and let K be the amount of physical stocks employed in the in-kind subsidy process. As with the previous model, the price and quantity equilibrium conditions can be stated as:

$$\begin{aligned} PS &= PD + V \\ (9) \quad QD &= QS + K \end{aligned}$$

The connection between V and K requires attention. First, assume that K is provided free to sellers or their trading agents on some announced basis, and they are entitled to use these stocks as they wish. Next, assume that competition in this market insures that the total revenue from all sales is used to purchase commercial supplies, namely:

$$(10) PD \cdot QD = PS \cdot QS$$

Then, using the equilibrium equations in (9), we can restate equation (10) as follows:

$$(11) PD (QS + K) = (PD + V) QS$$

Then

$$(12) PD \cdot QS + PD \cdot K = PD \cdot QS + V \cdot QS$$

and

$$(13) PD \cdot K = V \cdot QS$$

Equation (13) is the crucial equilibrium connection between V and K and can be added to the equations in (9). It illustrates that the market value of the in-kind dispersement ($PD \cdot K$) is equivalent to the overall subsidy value on commercial sales ($V \cdot QS$). Thus, in this particular setting, the in-kind stock dispersement involves no direct cash cost to traders. They acquire value only as they are sold for cash in the market.

Market Results

The equilibrium solution for prices and quantities in this in-kind subsidy environment are exactly parallel to equations (18) through (21), namely:

$$(14) PD = PE - [d/(b+d)] [V + K/d]$$

$$(15) PS = PE + [b/(b+d)] [V - K/b]$$

$$(16) QD = QE + [db/(b+d)] [V + K/d]$$

$$(17) QS = QE + [db/(b+d)] [V - K/b]$$

These four equations are preliminary equilibrium solutions. This is because, (1) V and K are linked together systematically whereas C and I in the previous section were not, (2) some further condition to determine either V or K must be specified to close this system, and (3) the equation (13) linkage between V and K involves PD and QS which are themselves variables determined within the model.²

Program Operation

To probe the first two of these issues it makes sense to specify a bit more pointedly how various in-kind subsidy programs might function. Here are the three examples briefly mentioned earlier:

1. V^* is set by policy makers as the per unit subsidy to be achieved in monetary value, and then the volume of K required to meet this goal is released into the market. Then:

$$(18) K = (QS/PD) V^*$$

2. K is released as a fixed proportion of QS. Then K is a premium quantity added to commercial sales; "sell five tons, get one free," for instance. Here $K = \alpha QS$, where α is a predetermined positive value. Then:

$$(19) K = \alpha QS \text{ and } V = \alpha PD$$

3. K^* is set by policy makers as the inventory disposal to be achieved. Then V is the resulting per unit subsidy equivalent that occurs in the market. Such an objective might be achieved by the central authority making sales equal to K^* and then distributing all the proceeds to sellers as a per unit price enhancement on the volume of QS. Therefore:

$$(20) V = (PD/QS) K^*$$

Other schemes to establish V or K can be concocted, but these three probably cover the most plausible alternatives and are suggestive of those currently being applied in actual practice.³ Irrespective of which method is seized by the authority, the final bracketed terms in equations (14) through (17), involving V and K, will determine how and in what direction any in-kind subsidy program will affect the market's prices and quantities in relation to the benchmark values.

In-Kind Subsidy Results

Since V, K, b, and d are all positive, it is clear from equation (14) and equation (16) that any in-kind subsidy scheme will lower prices paid by buyers and raise the total volume moving in the system. Equations (15) and (17) indicate that the effects of in-kind subsidization on sellers' prices (PS) and commercial sales (QS) are problematic and depend upon the sign of the term $[V - K/b]$.

If $[V - K/b]$ is positive, the in-kind program will raise sellers prices and commercial sales. If it is negative, PS and QS will fall. Let us see what is required for this term to be positive, namely:

$$(21) [V - K/b] > 0$$

Using equation (13), the equations in (9), and the basic demand function, $QD = a - bPD$, the following relationship holds:

$$(22) [V - K/b] = [V/bPD] \cdot [a - 2QD + K]$$

Hence, the original bracketed term in equation (21) will be positive if:

$$(23) [a - 2QD + K] > 0$$

The economic meaning of this particular expression may not be obvious. However, a closer look is quite revealing. The bracketed term in (23) will be positive when:

$$(24) QD < (a/2 + K/2)$$

Figure 1 illustrates the economic sense of this relation. The point $a/2$ on the horizontal axis is the quantity demanded when the price elasticity of demand (ϵ) is -1.0 along this linear function. As long as the total quantity moving into consumption in this market is less than $(a/2 + K/2)$, then both PS and QS will be larger than PE and QE. This is tantamount to saying that the in-kind subsidy will work to the direct advantage of commercial sellers only when the market demand is price elastic. [The $K/2$ term in (24) allows for the fact that total revenue from sales ($PD \cdot QD$) will actually increase along a linear demand curve from the point $(a/2 - K/2)$ to any point short of $(a/2 + K/2)$, even though the latter is in the inelastic range of the demand function.]

This is a rather powerful result and a stringent requirement for successful in-kind subsidy program from the sellers' point of view. To repeat, this analysis shows that for an in-kind subsidy program to be able to raise prices to sellers and to increase commercial sales, the demand in the market must be price elastic in the operational range. If the demand is inelastic, sellers' prices and commercial sales will drop as a result of the in-kind subsidy. Should unit demand elasticity prevail in the market, then PS and QS will not change no matter how aggressively the in-kind subsidy program is pursued by the authorities. Of course, as long as K is positive, government stocks are depleted and total sales volume will be higher than otherwise. This is consistent with the general results demonstrated earlier in geometric terms with a much more restricted model of proportional export bonuses (Houck, 1986). However, the present analysis demonstrates those results for a much wider class of in-kind

subsidy schemes.

The basic logic of this demand elasticity requirement can be confirmed by looking back at equation (10). If PS and QS are to increase along the sellers' supply curve, then $PS \cdot QS$ must also rise. Equation (10) indicates that $PS \cdot QS$ can increase only if $PD \cdot QD$ rises as an in-kind program is introduced or expanded. The value of $PD \cdot QD$ will rise only if the market demand function is elastic, no matter what its mathematical form.

A direct comparison of cash versus in-kind subsidies also may be useful. Suppose that C^* and V^* are established at the same per unit value. Because K (inventory disposal) is involved, the in-kind subsidy scheme will always result in lower prices and larger total sales to buyers than the equivalent cash subsidy. In addition, it will always generate lower prices and commercial sales for sellers than the equivalent cash subsidy. It is sensible to recall again that this analysis implicitly assumes that the absolute size of the central authority's inventory holdings has no effect on market prices.

Consider another direct comparison. Imagine that the demand function is price elastic so that the in-kind subsidy can potentially raise sellers' prices and commercial sales. Then how do the two schemes compare in their ability to generate identical values for PS and QS? To achieve the same PS and QS as a cash subsidy, the in-kind scheme must always involve a larger value of V than the corresponding value of C . This is because the required release of K into the market will put downward pressure on both PS and QS. In addition, achieving given levels of PS and QS with an in-kind subsidy will also decrease PD further than would a strictly cash subsidy.

In-Kind Subsidy for a Targeted Market

Let us now consider the effects of a targeted, in-kind subsidy scheme. Various theoretical aspects and estimates of how optimal targeted cash subsidies on exports might function are provided by Abbott, Paarlberg, and Sharples, by Sharples, and by Haley. As with a cash scheme, the in-kind subsidy program singles out at least one group of buyers for special treatment. Sales to them are augmented by in-kind subsidies, but sales to other buyers receive no subsidies. For such a scheme to operate as intended, the favored buyers must be clearly identifiable, and resale from the targeted market to buyers at large must be strictly ruled out.

For this discussion, let the subscript t refer to the targeted market and let the subscript w refer to the "rest of the world". The relevant demand and supply relations can be written as follows:

$$\begin{aligned} QD_t &= a - bPD_t \\ (25) \quad QD_w &= A - BPD_w \\ QS &= c + dPS \end{aligned}$$

With no subsidy or other intervention, the benchmark equilibrium conditions will be:

$$\begin{aligned} (26) \quad PS &= PD_w = PD_t = PE \\ QS &= (QD_w + QD_t) = QE \end{aligned}$$

The benchmark solutions for PE and QE are similar to those that emerge when the buyers are not separated. They are:

$$(27) \quad \begin{aligned} PE &= \left[\frac{a + A - c}{b + B + d} \right] \\ QE &= \left[\frac{ad + Ad + bc + Bc}{b + B + d} \right] \end{aligned}$$

Further,

$$(28) \quad \begin{aligned} QE_t &= \left[\frac{ad + aB + bc - bA}{b + B + d} \right] \\ QE_w &= \left[\frac{Ad + Ab + Bc - Ba}{b + B + d} \right] \end{aligned}$$

Keeping the same basic demand and supply system of equation (25), we can replace the equilibrium conditions of (26) with the following in-kind subsidy scheme:

$$(29) \quad PD_w = PS$$

$$(30) \quad PD_t = PS - V$$

$$(31) \quad QD_t + QD_w = QS + K$$

$$(32) \quad K \cdot PD_w = V \cdot QS$$

Equations (29) and (30) indicate that the subsidized price occurs only in the targeted market. Equation (31) is the quantity equilibrium relation involving in-kind dispersement. Finally, equation (32) indicates that the in-kind dispersements are turned into cash by the recipients in the non-subsidized market at the non-subsidized price.

The solutions for this targeted in-kind system parallel those for the single market. They are as follows:

$$(33) \quad PD_t = PE - \left[\frac{d + B}{b + B + d} \right] \cdot \left[V + \frac{K}{(d + B)} \right]$$

$$(34) \quad PD_w = PS = PE + \left[\frac{b}{b + B + d} \right] \cdot \left[V - \frac{K}{b} \right]$$

$$(35) \quad QD_t = QE_t + \left[\frac{b(d + B)}{b + B + d} \right] \cdot \left[V + \frac{K}{(d + B)} \right]$$

$$(36) \quad QD_w = QE_w - \left[\frac{bB}{b + B + d} \right] \cdot \left[V - \frac{K}{b} \right]$$

$$(37) \quad QS = QE + \left[\frac{dB}{b + B + d} \right] \cdot \left[V - \frac{K}{b} \right]$$

These solutions are preliminary in the same sense as equations (14) through (17). Their interpretation is straightforward. Equation (33) indicates that the price to buyers in the targeted market is always lower than the benchmark price because of the combined effects of V and K . Similarly, the quantity demanded in targeted market, indicated by equation (35), is always larger than the benchmark volume.

Whether or not the volumes purchased by and the prices paid by "rest of the world" buyers are higher or lower than the benchmark values depend upon the elasticity of demand in the targeted market, equations (34) and

(36). This result is controlled by the sign of the bracketed term, $[V - K/b]$, in these equations. As described earlier, this term is positive only when the demand in the targeted market is price elastic. Similarly, the results displayed in equations (34) and (37) show that the price received by sellers (and paid by non-subsidized buyers) as well as the volume of commercial sales will be elevated by a targeted in-kind subsidy scheme only when the targeted demand is price elastic. Otherwise, prices received and commercial sales will fall as government inventories are depleted.

Some Extensions

Using this analytical approach, more complex settings for in-kind subsidies could be explored. For instance, one could extend the targeted approach to numerous separate, favored markets, each with a different per unit subsidy value of V . In such situations, it is likely that the demand elasticity requirement for success would remain in tact but apply to a weighted average of the elasticities in the various targeted markets.

Multiple commodities could be introduced. Subsidies could be applied to sales of product X and in-kind dispersement of product Y might occur. Alternatively, traders could be permitted to select their in-kind payments from stocks of X and Y. Such elaborations of the basic framework would be possible using combinations of the simpler models described in this paper.

Other producers and sellers of the commodities in question might be introduced, some who also subsidize their sales, and some also who do not. In this context, subsidy retaliation among rivalrous sellers could be considered explicitly. Naturally, the simplest way to capture retaliation

to a given subsidy increase is to build the expected reaction by other sellers directly into the net demand function faced by the subsidizing seller. Other, more elaborate approaches also could be developed using these models.

Conclusions

In-kind price subsidies are a new and important feature of U.S. agricultural policy. Yet the specific market effects of such subsidies have not been widely discussed in the professional literature despite the fact that they differ importantly from similar cash subsidies. This paper examines the basic economics of in-kind subsidies with simple, static demand and supply functions.

In-kind price subsidies push down prices to favored buyers and increase total sales relative to no subsidy or even relative to an equivalent cash subsidy. Inventory holdings by the subsidizing authority or government are naturally diminished. This may be a major goal of the program. However, the effects of an in-kind subsidy upon prices received by sellers and commercial sales volume (net of stock disposals) are problematic, depending upon the price elasticity of demand in the subsidized market. If the demand is price elastic, then an in-kind subsidy will increase prices received by sellers and commercial sales volume. But if the demand is inelastic, including retaliation by other sellers, then sellers' prices and commercial sales volume will drop relative to the no-subsidy situation or relative to an equivalent cash subsidy. These conclusions do not depend upon the methods by which the in-kind subsidy scheme is administered.

FOOTNOTES

¹To simplify this discussion, we may visualize "traders" as competitive market intermediaries functioning between "producers" and "consumers".

²The full simultaneous solution of this in-kind subsidy system, simple as it seems, involves an algebraic tangle that is beyond the scope of this paper to present. The non-linear linkage between V and K, which also involves PD and QS is the main source of difficulty. A copy of the complete analytical solution for PD, QD, PS, QS, V, and K is available from the author.

³Another plausible operational scheme is a blend of 1. and 3. A fixed monetary appropriation (F^*) could be established in advance for the central authority to disperse to sellers (or buyers) as an in-kind subsidy. In such a case:

$$PD \cdot K = QS \cdot V = F^*$$

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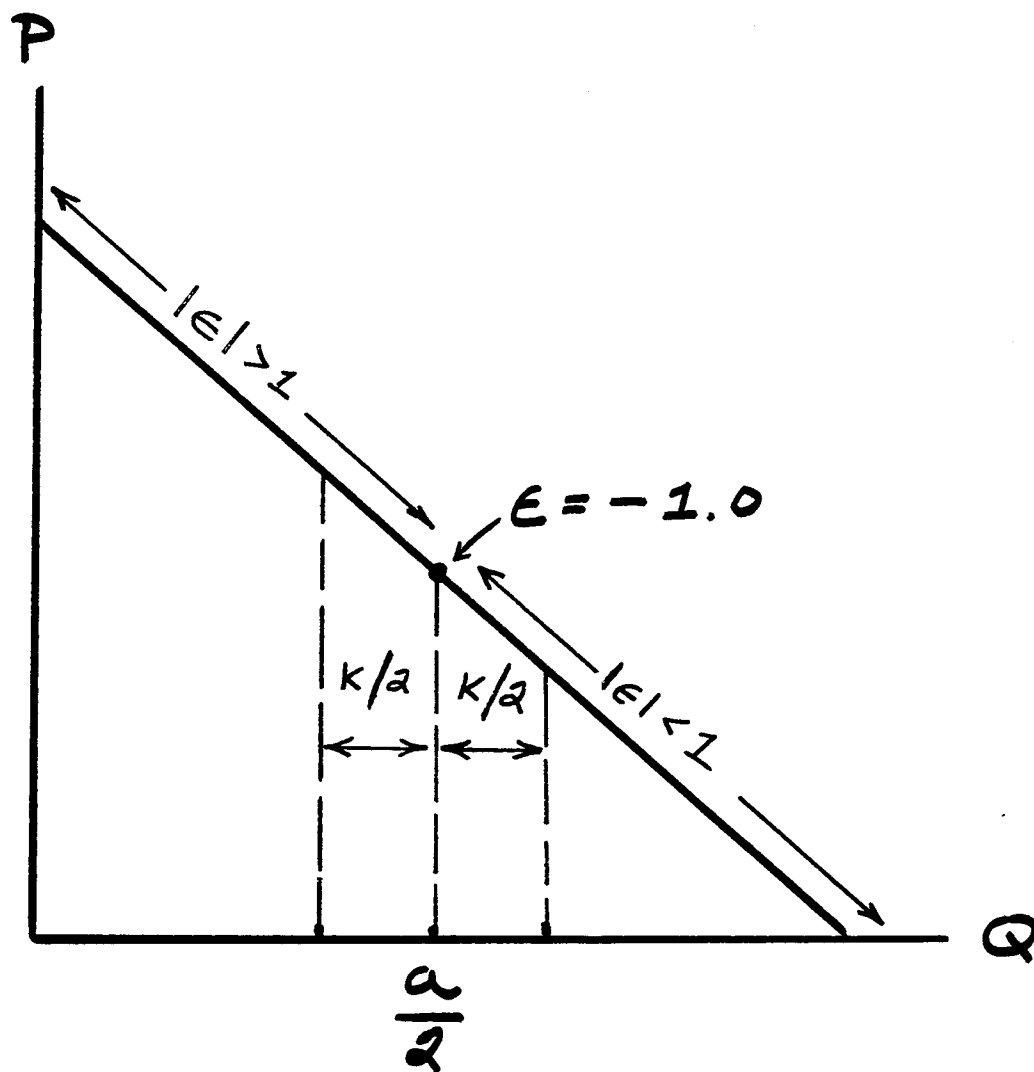


Figure 1.