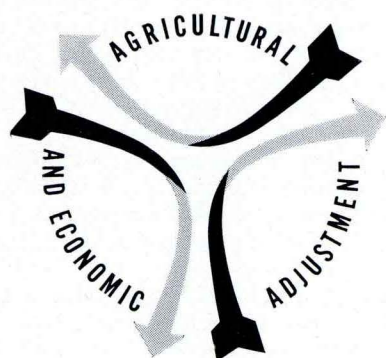# Analysis of Direct-Payment Methods for Hogs To Increase Hog Producers' Incomes

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CONTENTS

SUMMARY

It is difficult to stabilize or raise the prices of a perishable product like hogs by storage programs such as those that have been used for durable products like grain and cotton. Direct payments to make up the difference between free-market prices and the "support" level appear more promising for this purpose.

The Canadian government, for example, gave up its price-support programs for perishable farm products early in 1960 and initiated direct-payment programs instead. The payments for hogs were limited to 100 head of grades A and B hogs per producer.

This report includes estimates of the effects and costs of three different kinds of direct-payment programs for hogs that might be developed in the United States to attain alternative economic objectives. It draws upon the Canadian experience at several points but covers a much wider range of alternatives.

Following a review of the current Canadian direct-payment program for hogs, the three alternative types of direct-payment programs are studied for possible adaptation to the hog industry in the United States. They are:

1. *A program that would limit payments to 100 or 200 hogs per producer.*

2. *A program to restrict payments to a national quota distributed pro rata among hog producers.*

3. *A program to restrict payments to lightweight hogs.*

In the analysis of the first program, Agricultural Census data for 1954 are used to estimate the effects of direct-payment programs in the United States that would limit payments to a uniform maximum number of hogs per producer. About 89 percent of the producers in the United States would have their entire sales subsidized under a program with a 100-hog limit. About 97 percent of the producers would have their entire hog sales subsidized if payments were limited to 200 hogs per producer.

Producers outside of the Corn Belt would have the best relative position under limited direct-payment programs. Many of these producers have a relatively small volume, and their entire sales would be subsidized. A direct-payment program that would limit payments to 100 hogs per producer would be considerably more restrictive on producers in the important hog-producing regions where herds generally are larger.

The cost of a direct-payment program that would have provided a $2 per hundredweight direct payment for *all* hogs sold during 1954, the latest census year for which data are available, is estimated at $286,439,532. A program that would have limited payments to 100 hogs per producer would have cost an estimated $228,573,598, about 20 percent less than the program for all hogs. The program with a 200-hog limit would have cost an estimated $267,753,861, about 6 percent less than the program for all hogs.

The second program would restrict payments to a national hog-marketing quota. National pork consumption for 1959 is estimated on the basis of pork supply and distribution statistics available at the end of 1957 to simulate conditions that would have been encountered if a system of quotas had been in force at that time.

A hypothetical national marketing quota of 74,247,465 hogs projected for the 1959 marketing year is apportioned to producers on the basis of their relative marketings during a base period of 1954-57. As an alternative basis for allocation, the 1954-57 base is adjusted for regional trends in marketings, and quotas are assigned to producers on the basis of their probable relative marketings in 1959.

Estimates of the regional and national payments are made using actual 1959 marketing figures. It is assumed that the government would have paid each producer the difference between the support and the annual weighted-average market price for quota marketings. The hypothetical support price is $14.70 per hundredweight — 80 percent of the United States average price received by farmers for hogs from 1949 through 1958. The yearly weighted-average price is $14.07 per hundredweight; payments, therefore, would have been made at 63 cents per 100 pounds marketed. Total payments are estimated for both methods of apportioning the quotas. The total payment would have been about $109,000,000 for either method of apportionment. This payment is about 12 percent smaller than the $124,455,316 direct payment that would have been required to extend payment coverage to all hogs marketed during 1959.

If 1959 hog marketings could have been restricted to the quota, the estimated value of the smaller quota marketings would have been 11.44 percent greater than the actual value of the hog marketings in 1959. This would have raised the open-market price of hogs above the $14.70 support level so that no direct payments would have been required.

The third program, which covers the restriction of payments to lightweight hogs, would help to stabilize hog prices and to support hog returns in two ways: (a) Direct payments would add to producers' returns directly; and (b) if the payments induced marketing at lighter weights, the total tonnage going to market would be reduced in the short run, though not in the long run.

The difference between the prices of different weights of hogs results from the relative supply and demand for hogs in the various weight groups. The price differential between light and heavy hogs would change as the percentage of lightweight hogs increased, and this eventually would offset part or all of the direct payments.

Analysis of the historical relationship between the percentage of different weights of hogs and the price differentials between them for the years 1956-59 shows that, as the ratio of light hogs to heavy hogs increases, the price differential between them decreases. On the average, a change of one in the ratio of light hogs to heavy hogs is associated with an opposite change of about 80 cents in the price differential, although this varies to some extent from year to year.

The payments needed to induce farmers to market their hogs below, say, 200 pounds, would have to be at least equal to the profit that farmers would make by carrying their hogs to heavier weights.

In determining the most profitable marketing weight, comparisons are made between the cost of keeping the hogs for a given period and their increase in value during the period. The weight gains and amount of feed utilized are taken from Atkinson's and Klein's figures on feed consumption and weight gains. A hypothetical ration is formulated of corn, meat scraps and soybean meal in the proportions needed to make up a 10-percent protein feed.

On the basis of actual *weekly* Chicago hog market prices, *monthly* United States feed prices, a farrowing date of April 15 and interest on investment at 5 percent per annum, the marginal revenues, marginal costs and incentive payments are calculated for 1949 through 1958.

To add more precision to the analysis, 12 farrowing dates (the 15th of each month) also are included. Total revenues, marginal revenues and marginal costs are again calculated. Three different types of hog prices are used in the calculation of the total and marginal revenues: actual weekly Chicago hog prices for 1955 through 1959; a fixed price of $16.18 per hundredweight (derived by averaging weighted-average barrow and gilt prices at Chicago over the 5-year period, 1955 through 1959); and weekly moving-average prices for Chicago (averaged over the same 5-year period for comparison).

The optimal marketing weights at which farmers receive the *greatest* amount of profit are calculated, and, from these, the incentive payments necessary to induce farmers to sell at or below 200 pounds are derived. It is assumed that the incentive payment must at least be equal to the profit the farmer could make by carrying his hogs to heavier weights.

With the exception of 1955, the estimated costs of a program to induce farmers to sell their barrows and gilts at 200 pounds or below are smaller when the fixed price of $16.18 per hundredweight is used than when moving-average prices or actual prices are used. The variation in total cost of the program from year to year also is less when the fixed price is used than when moving-average or actual hog prices are used. This variation results from (a) variation in the number of barrows and gilts slaughtered and (b) variation in feed costs.

The total costs of the program in 1956, 1957 and 1958 would have been less when moving-average prices are used than when the actual prices are used. In 1955 and 1959, the total costs would have been higher when moving-average prices are used than when the actual prices are used.

A direct-payment program of this type in the short run would reduce the total tonnage of pork coming to market. The estimated reduction in total pork production in 1959 is 587,389,680 pounds. This assumes a program that could lower the average weight of barrows and gilts in commercial slaughter from 228 to 220 pounds. This is equivalent to a reduction of 2,576,270 barrows and gilts that average 228 pounds.

In the long run, however, the increase in the supply of lighter weight hogs relative to the supply of heavier weight hogs could cause the price differential between the two to become smaller — and possibly even to change in favor of the heavier hogs. This would offset part or all of the direct payment. A new equilibrium between prices of light and heavy hogs and the direct payment would be reached — unless this is compensated for by larger payments. Estimates are made of both the increase in price resulting from the decrease in production and of the increase in production following this increase in price.

Analysis of Direct-Payment Methods for Hogs To Increase Hog Producers' Incomes[1]

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In recent years, commodity loan and storage operations have been used extensively to implement price-support programs for storable agricultural products. Programs of this sort have met with varying success. However, their use for perishable products is limited. Pork, for example, cannot be stored for more than a few days fresh or for more than a few months cured or frozen before it will begin to deteriorate.

Accordingly, different kinds of programs are being considered for perishable products. One of these programs would let prices seek their own level in the market and use direct payments to farmers to make up the difference between market prices and some preset level of price "support." This bulletin reports an analysis of how such a program might work for hogs.

Economic Framework

This study is concerned with the use of direct payments and production quotas for hogs in an attempt to increase hog producers' incomes. A statement of the basic problem is relatively simple. In the long run, a price below the equilibrium level, *ceteris paribus*, will discourage production, and a price above that level, without effective controls on output, will result in surplus supplies which depress prices and incomes.

The cyclic pattern in hog slaughter and prices, as shown in fig. 1, is the result of producers' expectations of what prices will be at the end of one production period; i.e., the time required for gestation plus feeding — about 10-12 months. Since current prices seem to be the major criterion for determining these expectations, errors are made, and the cycle is perpetuated. Producers do not react immediately to higher or lower prices. Instead, they wait for a period of several months to a year before making adjustments in their hog operations. As a consequence, hog production and prices tend to move in about a 4-year cycle.

These cyclic fluctuations in hog production and prices affect the hog-pork industry from the producer to the consumer. During the part of the cycle when hog production is low, labor and other production, processing and distribution resources are not fully used. Subsequently,

they are overburdened when hog production is at its peak in the cycle. This increases costs which, in the end, are paid for by both the producer and consumer. From a sales standpoint, too, the customers that are lost during the period of low production and high prices are hard to win back during periods of lower prices — adding even greater impetus to the declining per capita consumption of pork (28).

Direct payments establish a floor below which prices cannot fall — at least as far as the producer is concerned. Prices are, in fact, free to fall or rise to any level, but the direct-payment procedure, in effect, establishes the minimum price that producers will receive. Therefore, in the producer's decision-making process, his expectation of future prices would begin with the guaranteed price and vary only upward from it. This eliminates much of the uncertainty in his expectations — the exact amount depending on the level at which the guaranteed price is set.

Direct payments for the purpose of stabilizing hog production and prices against the cyclical patterns shown in fig. 1 have been analyzed in an earlier report (28). For stabilization purposes, the base price "support" level would be set at a little below the long-run equilibrium price, say $13 per 100 pounds. Then, whenever the market price of hogs declined below $13, for example,
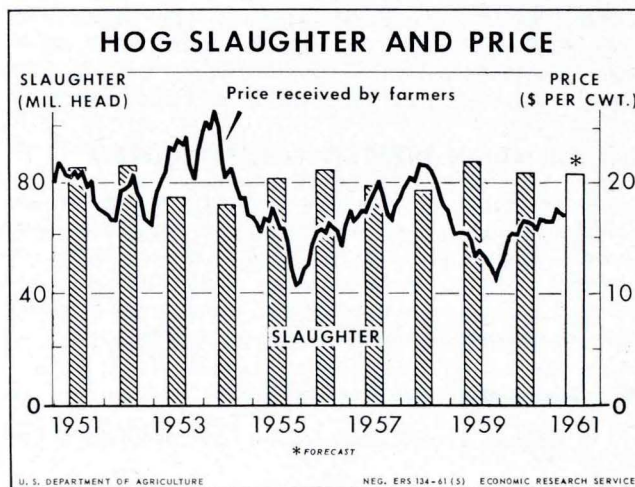

Fig. 1. Hog slaughter and price received by farmers, United States, 1951-61.

to $12, the government would make up the difference in the form of a direct payment to the farmers of $1 per 100 pounds for all hogs sold. This would keep returns up to average levels, so that farmers would not be driven by low prices to curtail hog production and thus to perpetuate the cycle.

Direct payments to raise hog prices would be a different matter. The "support" price for this purpose would be set above the long-run equilibrium price, say at $16 per 100 pounds. But this would result in increased hog production — in response both to the higher prices and to less price uncertainty. This would tend to drive hog prices down, making larger direct payments necessary. And the payments would have to be made on an increasing number of hogs. This could continue until public criticism of the size of payments forced a reduction in the base price.

This report presents analyses of three types of direct-payment programs, all of which are designed to increase hog producers' incomes. In general, the analysis of each program covers (a) farmer response in terms of output to price changes, (b) cost to the government for specific price changes and (c) benefits, if any, to farmers and consumers.[2]

Order of Presentation

The first program analyzed would limit payments to a uniform number of hogs per producer; Canada adopted a program of this sort in 1960, setting the number at 100 head. The second program would restrict payments to a national quota, and the third would restrict payments to lightweight hogs.

These are considered in turn, beginning with a program that would limit payments to a uniform number of hogs per producer. The Canadian government abandoned its price-support program for hogs in 1960 and replaced it with a direct-payment program of this sort. The support price for 1960 and 1961 was set at 80 percent of the 10-year moving-average base price, which is the minimum support level allowed. Hence, the program is a price-stabilizing program. However, even with the support price set at the 80-percent level, some of the price uncertainty is removed, and repercussions can be expected on the price expectations of hog producers. For this reason, as well as to obtain a knowledge of the first direct-payment program used for hogs, we will first report on the Canadian program for the bearing it may have on possible direct-payment programs in the United States.

THE CANADIAN DIRECT-PAYMENT PROGRAM

The Canadian government adopted a system of "deficiency payments" and other means of supporting farm incomes on Jan. 11, 1960 (18, p. 2). This program is examined to gain some knowledge of the operation and effect of a direct-payment program, which might be adaptable for use with United States hog producers.

The Agricultural Stabilization Act

In Canada, income support for farm products is provided by the Agricultural Stabilization Act. This act went into effect March 3, 1958 (17). Some of the features of the act are (22, pp. 2-3):

(a) Any agricultural product is eligible for support. The decision as to which product will be supported is the responsibility of the government.

(b) Nine basic commodities are supported at all times. These commodities are: cattle, hogs, sheep, butter, cheese, eggs, wheat, oats and barley. The support provided to the nine basic commodities is at a minimum of 80 percent of the average price of these commodities, at selected markets across Canada, during the previous 10 years.

(c) Several methods of support are provided, including purchase and storage, direct payments, flat income payments on a per-acre basis or any other method which might be considered most appropriate to meet the need.

(d) The agency responsible for the administration of the act is the Agricultural Stabilization Board.

Direct payments were not used initially, after the passage of the Agricultural Stabilization Act in 1958, to support the incomes of Canadian hog producers. Instead, hog prices were maintained at support levels by direct purchase and storage of pork by the government.

In April 1958, the Canadian government set a support price of $25 per hundredweight for grade A carcasses at Toronto (18, p. 44). This level of support was in effect until Oct. 1, 1959, after which the support price was reduced to $23.65 per hundredweight at Toronto. This new lower support price was to be maintained until March 31, 1960. Both of the support prices were seasonally flat.

By November 1958, preparations had been made by the Canadian government to make purchases of pork at public stockyards wherever and whenever necessary to maintain hog prices at support levels (13). Hog prices at public stockyards only were supported, and prices at other points were left to seek their own levels relative to public stockyard prices.

The carcass cuts purchased by the Agricultural Stabilization Board were prepared at government inspected plants in accordance with prescribed specifications and placed in cold storage in behalf of the board. Cuts were invoiced in balanced proportions; i.e., equal numbers of each cut. However, to promote maximum distribution and consumption, provisions were made to allow sellers to retain certain cuts which were likely to be in short supply.

Figures on the actual pork accumulations of the Agricultural Stabilization Board are fragmentary. By May 1959, the Canadian government had accumulated 70,000,000 pounds of pork in cold storage. Normal storage for this time of year is about 18,000,000 pounds (14). A preliminary estimate made in November 1959 indicated that total marketings for 1959 would be about 8,800,000 hogs (8, p. 45). This estimate indicated that domestic disappearance of pork would account for about 7,000,000 of the hogs marketed. Exports of pork and hogs would account for an additional half million hogs. The surplus of approximately 1,300,000 hogs, or 14.8 percent of the marketings, would be accounted for principally by Agricultural Stabilization Board purchases.

This quantity was considered too large to be handled by the government purchase program. Accordingly, in

October 1959, the Canadian Department of Agriculture announced that the direct-purchase program would end after Jan. 9, 1960, to be replaced by a direct-payment program (8, p. 44). The Canadian Department of Agriculture had previously announced that direct purchase of pork would continue until March 31, 1960.

Some of the pork accumulated under purchase activities was canned to prevent spoilage. On March 4, 1960, after the termination of the direct-purchase method of support, Agricultural Stabilization Board holdings of canned pork consisted of 94,000,000 pounds of canned luncheon meat and 8,400,000 pounds of canned hams (10, p. 11). The canned luncheon meats were made available, free of charge in carload lots, to approved charitable institutions and welfare organizations in Canada and other countries.

Figures on the value of pork inventories accumulated under the direct-purchase program are available from the annual reports of the Agricultural Stabilization Board. On March 31, 1959, pork inventories were valued at $20,-836,220 (6, p. 2). On March 31, 1960, pork inventories were valued at $74,085,444 (7, p. 2). Pork inventories accounted for 62.9 percent of the total value of inventories held by the Agricultural Stabilization Board on March 31, 1960.

The Direct-Payment Program

Minister of Agriculture Douglas Harkness indicated some of the policies behind present Canadian price- and income-support legislation in an address at a meeting of the National Farm Institute at Des Moines, Iowa, in February 1960 (22, p. 3). The policy objectives mentioned were: (a) providing security of income to the bulk of Canadian producers, (b) maintaining flexibility in the level of support and, as far as possible, flexibility in deciding which commodities are to be supported and (c) improving the quality of products marketed. The provisions for carrying out these policies are evident in the Agricultural Stabilization Act and in the program of direct payments for hog producers as provided for under the act.

In the direct-payment program for hogs, payments are made for a maximum of 100 grade A or grade B hogs per registered producer (22, p. 5). Canadian Minister of Agriculture Douglas Harkness reported that, prior to 1960, about 90 percent of the producers in Canada had commonly marketed less than 100 grade A or grade B hogs per year. For this reason, the limit was set at 100 head (21, p. 5). Rackham (26) reported that, in 1959, about 70 percent of the hogs marketed in Canada could have been included under the limit.

Canadian hog producers are required to register with the Department of Agriculture, indicating their intention to participate in the program, and receive a registration number to become eligible for direct payments. Each producer is required to give the legal description of the location of his hog enterprise in applying for a registration number (15). Only one registration number is issued per farm, and only 100 hogs are eligible for direct payments from each farm, regardless of the number of owners. The Canadian government can prevent payments from being made for more than 100 hogs from each enterprise when the legal location of each enterprise is known.

When hogs are sold and graded, the producer's registration number is recorded on the carcass grading certificate. Carcass graders then forward copies of the grading certificates to the data processing unit of the Canadian Department of Agriculture where the number of grade A and grade B hogs marketed by each producer is recorded (15). The Canadian government can use these figures to determine the number of hogs eligible for direct payments from each producer when direct payments are necessary.

Approximately 183,000 producers registered to participate in the deficiency-payment program in 1960 (2). This is about 64 percent of the total number of farms indicating a hog enterprise at the time of the 1956 census. However, some of the producers, who indicated a hog enterprise at the time of the census, raised hogs only for home consumption (16).

The program provides for an annual determination of payment size and payment distribution. No provisions are made for interim payments. At the end of the year, the Canadian Department of Agriculture computes the annual weighted average price of grade A carcasses from the weekly prices paid at the major Canadian markets. If this price is less than the support price, each registered producer receives the difference between the annual weighted average price of grade A carcasses and the support price for a maximum of 100 grade A or grade B hogs. The program requires that the same payment per hundredweight be made for all hogs sold that were eligible for direct payments. The difference between the support price and the national weighted average price of grade A carcasses also determines the size of the direct payment for grade B carcasses.

For 1960, the support price for grade A carcasses was set at $22.65 per hundredweight (23). This was 80 percent of the 10-year average base price and the minimum level of support allowed under the Agricultural Stabilization Act. The support price for 1961 was again set at $22.65.

Seasonal price patterns are left intact by this program. Producers are induced to get the maximum price per hundredweight for each hog sold. The direct payment an individual producer could receive is independent of his sales price. Though this program does not remove all price uncertainty for the producer, it does place a floor below which the yearly national weighted average price cannot deviate. This floor pertains only to the producer, since the market price is free to rise or fall to any level. Hence, certain repercussions can be expected on the price expectations of hog producers.

From the standpoint of an individual producer, however, much of the price uncertainty remains under this direct-payment program. This is because the size of the direct payment per hundredweight cannot be determined until the end of the year. Producers could market hogs at prices substantially below the support price and not receive direct payments, since price increases later in the year could raise the national weighted-average price above the support level, and no payments would be made at the end of the year.

Initial effects of the program

Some congestion occurred at Canadian markets immediately before the transition from the direct-purchase

to the deficiency-payment program. Producers marketed hogs in increased numbers at weights too light to qualify as grades A or B in an effort to market as many hogs as possible before the end of the direct-purchase program.

The associate director of the Livestock Division, Canada Department of Agriculture, made an appeal to producers for an orderly change-over to the deficiency-payment program in December 1959 (15). Producers were told that clogging markets would mean delayed slaughter and unnecessary shrinkage, that the government quality bonus would not be paid for hogs too light to grade A or B and that lightweight hogs are subject to a packer discount of about $3.50 per hundredweight below that paid for grade A hogs.

Marketings during the first week of January exceeded the slaughtering capacity of most plants, and some hogs had to be carried over for slaughter into the next week (10, p. 11).

Estimating the effect of the deficiency-payment program on marketings is difficult. The marketing figures are fragmentary, and some are of a preliminary nature. Farrowings were down 7 percent during June through August of 1959 as compared with the same period in 1958 (9, p. 11). This reduction in farrowings occurred before the formal announcement in October 1959 by the Canadian Department of Agriculture that direct purchase of pork would end Jan. 9, 1960. There were earlier announcements, however, that the direct-purchase program would be replaced as soon as feasible by a direct-payment program. A December 1959 survey of pigs on farms showed a smaller percentage decrease than is normal for the cyclical downturn, according to past relationships (10, p. 12).

Marketings in 1960 declined considerably from 1959 cyclical peak levels. Preliminary estimates for the first three quarters of 1960 indicated declines of 10 percent, 14 percent and 31 percent, respectively, in average weekly slaughter as compared with the same quarters in 1959 (11, p. 10). An estimate derived from a June 1, 1960, survey of pigs on farms indicated a 27-percent decrease in average weekly marketings for the last quarter of 1960 as compared with 1959.

The downturn in marketings during 1960 allowed the Agricultural Stabilization Board to dispose of much of the surplus cold storage stocks accumulated under the direct-purchase program. Domestic disappearance and exports during the summer months of 1960 exceeded market supplies (12, p. 14). Cold storage stocks were 26 million pounds at the end of July, compared with 50 million pounds at the beginning of May and with 72 million pounds at the same date a year earlier. Cold storage stocks were reduced to normal operating levels at the end of the summer.

At the beginning of the deficiency-payment program there was some concern about increased Canadian pork exports to the United States. There was a probability that the United States would impose countervailing duties on pork imports from Canada with the beginning of the direct-payment program (9, p. 12). In an effort to prevent a countervailing duty from being enacted, the Canadian government imposed an equaliziation fee which would compensate for any subsidies that would be paid under the deficiency-payment program. This removed the subsidy from some Canadian exports to the United States. Exports to the United States of primal cuts or products of primal cuts from hogs eligible for deficiency payments may be made only under a special export permit which is issued only on payment of the equalization fee. Exports of other pork products are made on an open permit and are not subject to the equalization fee. The equalization fee export provision went into effect Jan. 25, 1960.

The reaction of producers to the program

Officials of the Canadian government met a considerable amount of opposition from producer groups when they announced that the direct-purchase method of support would be replaced by direct payments. Large-scale producers complained that they — the most efficient producers — were unfairly discriminated against by the limit-of-payments provision. Contracting firms and large-scale producers had expanded feeding and rearing facilities, assuming that the direct-purchase program would continue.

The direct-purchase program, while in effect in 1958 and 1959, guaranteed most large-scale producers that hog prices would not decline below their production costs. Support levels had been set on the basis of costs of production. As mentioned earlier, the support price was set at $25 per hundredweight at Toronto for 1958. This support level was in effect until Oct. 1, 1959, after which it was lowered to $23.65 at Toronto.

Under the direct-payment program, the large-scale producers could receive subsidies for only 100 hogs. Many large-scale producers and contracting firms planned cutbacks or withdrawals from hog production after the details of the direct-payment program became known (26).

At the outset, small-scale producers complained because their immediate returns would be low. Those who marketed hogs early in 1960 feared that a price rise later in the year would raise the grade A average price above the support level so that no direct payment of any size would be made.

The fact that direct payments would be made only at the end of the year was disliked by many producers. There were demands for interim payments early in 1960. However, price increases associated with lower hog marketings later in the year decreased the demands for interim payments.

Some producers found it difficult to understand the operation of the program. Among these were producers who thought they could receive no payments if they sold hogs at prices above the support level. Others thought that, if they sold hogs at any price below the support level, the difference, no matter how large, would be made up by the government.

Possible Adaptations for United States Hog Producers

The Canadian deficiency-payment program for hogs has four primary characteristics. These are: (a) the use of a moving-average base price, (b) the limitation of payments to 100 head of hogs per producer, (c) the limitation of payments to high-grade hogs in an effort to improve the quality of hogs marketed and to reduce program costs and (d) the provision for making the payments on an annual basis.

These features are discussed in the order presented, and a brief appraisal is made of their applicability for a direct-payment program for the United States producers.

A moving-average base price

A moving-average base price has some characteristics that make it superior to parity as a method of establishing a support level. Parity prices are affected by economic conditions that existed in the distant past. Parity prices also tend to overvalue some commodities relative to others, although this effect has been reduced by the use of "modernized parity" (21, p. 696). Technology generally has contributed more to cost reduction in the production of crops than of livestock. The result has been an overvaluation of certain crops, such as cotton and wheat. A moving-average base price embodies more recent economic relationships than do parity prices.

A shorter base period than the 10-year period used by the Canadians could be used. The shorter moving average, however, would be affected to a greater extent by periods of large or small marketings. For example, 1 year of very small marketings could cause a sizable increase in a 4-year moving-average base price.

The fact that the support price is 80 percent of the previous 10-year moving-average base price means that the Canadian government does not intend to raise hog returns (prices plus payments) above long-run equilibrium levels. They will protect producers only from price declines that are greater than 20 percent below average. The Canadian program, therefore, is a price-stabilizing program — not a price-raising program.

Limitation of payments to 100 hogs per producer

The reasons why the payments are limited to 100 hogs per producer are not clear. If prices (returns) were to be supported above long-run levels, a limitation of this sort might be imposed in an attempt to limit total production and to keep it within the bounds of quantities that could be sold at the higher prices. But since prices (returns) are to be supported only at 80 percent of previous average levels, no quantity limitations appear to be necessary. A support price set at 100 percent of previous average levels could be expected to increase production, but the provision of price certainty at only 80 percent of previous average levels can't be expected to increase production enough to depress prices below 80 percent of previous levels.

It is possible that the subsidies are allocated in proportion to need, rather than in proportion to the total number of hogs sold, when the payments are limited to a maximum number of hogs per producer. Huge subsidies to large-scale producers, who may have more than adequate incomes without additional government aid, are eliminated. However, the limit-of-payments provision could also discourage large-scale producers and serve as a subsidy to inefficiency.

Limitation of payments to high-grade hogs

A limit-of-payments provision designed to improve the quality of hogs marketed would be difficult to incorporate in a direct-payment plan for United States hog producers. Some hog buyers find it difficult to estimate accurately the grade and value of the pork cuts a hog will yield when slaughtered. Some undervaluation and overvaluation of hogs occurs with the live-animal grading system. As a result, slaughter hogs of the same class and within the same weight range usually sell at about the same price per hundredweight (19, p. 51). The grades used by different meat packers also vary. An improved, standardized live-animal grading system or a carcass grading system would seem necessary before payments could be limited to producers of high-quality hogs in the United States.

Annual payment procedure

The annual payment procedure has administrative and economic advantages. Administrative expense is lessened by making only one payment to each producer at the end of the year. The problems involved in setting seasonally adjusted base prices do not occur. Producers are induced to get the maximum price for each hog sold. The program provides no incentive for producers to increase marketings during periods of heavy seasonal marketings to reduce production costs.

The annual procedure adopted for making the direct payments, although administratively less expensive than making interim payments, was disliked by some Canadian producers. They did not like the idea of waiting 1 to 12 months for direct payments that they were not sure of receiving. Also, much of the price uncertainty remains when the the payment size is determined by the difference between the weighted-average market price and the support price for the entire year.

The procedure used by the Canadians for making the direct payments could be adapted to a direct-payment program for United States producers. A variation of this type of payment determination is currently used in the direct-payment program for wool producers. Under the wool program, each producer receives the percentage required to increase the national average wool price per pound up to the incentive level — 62 cents per pound — at the end of the marketing year (38, p. 17). A program that would provide payments after every week or month, if the average market price dropped below the support level, might be preferred by producers. If the weekly or monthly prices were announced a sufficient time in advance, price uncertainty could also be lessened to a greater degree, and greater efficiency in resource allocation could be achieved.

A direct-payment program with monthly support prices would be simpler to administer than one with weekly support prices. The government would establish and announce 12 support prices rather than 52. Objections can be raised against the use of monthly support prices, however. A monthly support price might induce producers to hold hogs over for 1 or 2 weeks to take advantage of a higher support price the next month. Objections also could be raised by producers if sharp price changes occurred within a month. For example, if the program made up the difference between the average market price and the support price for a month, a producer who sold hogs early in the month, when prices were high, would get a substantially greater total return than the producer who sold later in the month after a significant price decline.

Figure 2 shows the average percentage of the yearly barrow and gilt marketings at eight terminal markets[3] for each week and the average weekly prices for 1956

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[3]The eight terminal markets are Chicago, St. Louis, Kansas City, Omaha, Sioux City, St. Joseph, St. Paul and Indianapolis.
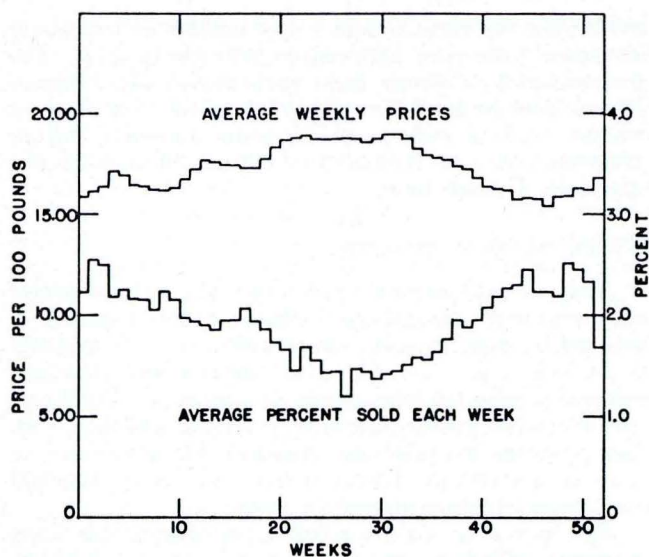
Fig. 2. Average weekly barrow and gilt prices and the average percent marketed each week at eight terminal markets, 1956 through 1959.

through 1959 (33). The price variations associated with the variations in marketings are fairly great within some months. It seems likely that weekly support prices would be needed to take this detailed price variation into account.

A weekly support price could be established at some percentage of the average weekly prices during the past period. The weekly support levels could be determined and announced approximately a year and a half in advance. The weekly support prices could then serve as forward prices for production planning.[4]

A long or short base period could be used to compute the weekly base prices. The base period would probably have to be at least 4 years to average out the effects of the hog cycle. A 10-year moving-average weekly base price, however, might be criticized because some of the prices used to compute it are influenced by economic conditions too many years in the past. If fewer years are used to compute the moving-average weekly base price, however, it is affected to a greater extent by weeks of large or small marketings and by shifts in seasonal patterns.

The difficulties of establishing these weekly support prices a year and a half in advance (or longer, if producers are to be notified in time to retain more or fewer sows for breeding purposes rather than market them for slaughter) are very great. Forecasts of prices made by Wilbur Maki at Iowa State in recent years have been reasonably accurate up to a year in advance, but beyond that period they become unreliable. Government price analysts attempting to set price-support levels, below which direct payments would be made, would have to take several unpredictable future government actions into account — for example, new feed-grain programs, (who can say what feed-grain programs we will have 2 years from now). The analysts must also consider the rather unpredictable effect that the announcement of a direct-payment level of price supports would have on hog production and, therefore, on hog prices.

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[4]Don Rohdy developed a refined and somewhat more complicated system of establishing direct-payment support prices based on the projection of postwar seasonality trends for various barrow and gilt weight groups. An outline of this procedure is available from the senior author.

Considerations of this sort mean that many more resources would need to be devoted to building the foundation of factual and analytical methods for price projections before it would be sensible to try to put a direct-payments program into effect. Such considerations also mean that the level of support would need to be conservative until considerable experience had been gained.

In the alternative direct-payment programs for United States producers considered in the following sections, several features of the Canadian program are used. Some of the features are used without change; others are modified in an attempt to fit them to the objectives of individual programs.

ESTIMATED EFFECTS OF PAYMENTS LIMITED TO A MAXIMUM NUMBER OF HOGS PER PRODUCER

The first program considered is a direct-payment program for United States producers that would limit payments to a maximum number of hogs per producer. The features of this program are similar to the Canadian program, with the exception of the quality restriction on payments. No attempt is made to estimate the effects of restricting payments to producers of high-quality hogs.

For this program, estimates are made of the effects of alternative sizes of limits that might be imposed. Estimates are made of the percentage of producers who could have had their entire hog sales subsidized, and the percentage of volume that could have been subsidized under alternative limits to obtain estimates of the extent of program coverage.

All estimates are based on 1954 figures, since this was the last year for which the needed census data were available at the time of the study. All programs considered assume 100 percent producer participation.

Estimated Effects of Alternative Size Limits

The effects of two alternative size limits are estimated — a 100-hog limit and a 200-hog limit. Smaller size limits could have been considered, but a preliminary investigation indicated that the smaller limits would have been highly restrictive.

It is hypothesized that a limit on the size of payments would have different effects in different areas of the country. Areas with generally small hog farms would have a higher proportion of sales eligible for subsidy. The effects of limiting payments are estimated on a regional basis to test this hypothesis. The following section involves the computation of the percentage of producers in the various regions who would have had their entire sales subsidized under the alternative limits.

Percentage of producers completely subsidized

The 1954 Agricultural Census gives the number of producers who sold less than 100 hogs and less than 200 hogs and also gives the total number of producers in each region (44, p. 505). Estimates of the percentages of producers who could have had their entire sales subsidized under the 100-hog and 200-hog limit-of-payments provisions are computed from these figures. These estimates for the nine Agricultural Census regions and for the United States are given in table 1.

Table 1. Percent of producers with sales completely subsidized, by region and for the United States under hypothetical limited direct-payment programs, 1954.[a]

Area	100-hog limit Producers completely subsidized	200-hog limit Producers completely subsidized
New England	92.8	95.8
Middle Atlantic	97.5	98.9
East North-Central	84.2	94.9
West North-Central	81.9	95.9
South Atlantic	98.1	99.5
East South-Central	98.3	99.6
West South-Central	98.6	99.6
Mountain	97.2	99.2
Pacific	93.2	97.1
United States	89.2	97.0

[a]Computed from U. S. Census of Agriculture (44, p. 505).

A considerable amount of variation in the size of enterprise existed among the regions. A high percentage of the producers in the South Atlantic region are small-scale producers; 98.1 percent marketed fewer than 100 hogs in 1954. By contrast, 81.9 percent of the producers in the West North-Central region sold fewer than 100 hogs. Nationally 89.2 percent sold fewer than 100 hogs, and 97 percent sold fewer than 200.

With payments limited to 100 hogs per producer, over 98 percent of the producers in the three southern regions could have had their entire sales subsidized in 1954. A 100-hog restriction on the size of payment would have had the least unfavorable effect on these producers. A program that would have allowed payments for a maximum of 200 hogs would have permitted complete subsidization for over 95 percent of the producers in all regions except the East North-Central, and even there the percentage would have been 94.9.

Percentage of volume subsidized

Estimates next are made of the number and percentage of hogs that could have been subsidized under the alternative limits. Here again, the estimates are made on the basis of 1954 Census of Agriculture figures.[5] For the 100-hog limit, the number that would have been eligible is the sum of the marketings from producers selling less than 100 hogs per year, plus 100 hogs each from producers selling over 100 hogs. The number eligible under the 200-hog limit is the sum of the marketings of producers selling less than 200 hogs, plus 200 hogs from each producer marketing over 200.

Table 2 shows the total hogs sold and the estimated number and percentage of hogs eligible for direct pay-

[5]A detailed description of the estimation procedure used is available from the senior author.

ments under the limited payment programs. The estimates are given for each region, Iowa and the United States. For the United States, the estimated number of hogs eligible for direct payments is the sum of the regional totals. Iowa estimates are included separately because of the state's relative importance in hog production. The Iowa estimates are also included in the West North-Central approximations.

For the United States, the estimated percentage of hogs sold in 1954 that could have been subsidized under a direct-payment program with a 100-head limit is 80.2 percent. The regional figures indicate that a 100-hog limit would have had a larger income effect on producers in the southern regions. The approximate figures indicate that over 95 percent of the hogs sold in these regions would have been eligible for direct payments under the program with the 100-hog payment restriction. Producers in the New England and Pacific regions would have had a considerably smaller percentage of their hogs eligible— only about 50 percent. Obviously, the large-scale producers in these regions marketed a major portion of the hogs. Producers in the East North-Central and West North-Central regions would have had about 75 percent of their sales eligible for direct payments. The number of hogs that would have been excluded from consideration in determining payments, however, is greater from these regions than from all of the other regions combined.

A direct-payment program that would have limited payments to 200 hogs per producer would have allowed payments for an estimated 93.6 percent of the hogs sold in the United States in 1954. A 200-hog limit provision would have been considerably less restrictive on producers in the East and West North-Central regions. It would have allowed payments for approximately 94 percent of the hogs sold in the West North-Central region — the most important hog-producing region. For the United States, an estimated 7,841,044 more hogs would have been eligible for direct payments if payments had been made for a maximum of 200 hogs per producer, rather than 100.

A Cost Comparison Between Limited and Unlimited Direct-Payment Programs

A direct-payment program that would provide payments for all hogs would make it possible for producers in all regions to get a greater subsidy than if limits are placed on the size of payments to individual producers, provided the payment per hundredweight is the same under both programs. The previous estimates indicate, however, that as a group, the producers in the southern regions would have had the best relative position if pay-

Table 2. Total hogs sold, estimated number and percent of hogs eligible for subsidy under hypothetical limited direct-payment programs, 1954.

Area	Total hogs sold	100-hog limit Number eligible	100-hog limit Percent eligible	200-hog limit Number eligible	200-hog limit Percent eligible
New England	154,724	75,018	48.5	97,060	62.7
Middle Atlantic	901,333	703,062	78.0	740,967	82.2
East North-Central	19,098,663	14,483,203	75.8	17,783,855	93.1
West North-Central	28,667,737	22,685,236	79.1	26,958,832	94.0
South Atlantic	3,665,380	3,574,203	97.5	3,613,698	98.6
East South-Central	2,898,591	2,840,441	98.0	2,853,373	98.4
West South-Central	1,712,700	1,640,222	95.8	1,676,638	97.9
Mountain	631,514	500,944	79.3	528,815	83.7
Pacific	799,716	420,045	52.6	510,180	63.8
Iowa[a]	14,344,666	10,000,100	69.7	12,993,142	90.6
United States	58,530,358	46,922,374	80.2	54,763,418	93.6

[a]Also included in West North-Central estimates.

ments had been restricted; a greater portion of their hogs would have been eligible for payments.

For comparison, estimates are made of the cost to the government under three hypothetical programs. The first program is constructed with no limit to the size of payments to individual producers; i.e., all hogs are assumed eligible for direct payments. The cost of these payments to the government is compared with the cost of those made under programs containing restrictions that limit payments to 100 and 200 hogs per producer.

Estimating the unlimited payments

A hypothetical direct payment of $2 per hundredweight is made for all hogs sold under the program that would provide unlimited payments. A payment of this size would have been made if the government had decided to increase the national average price of hogs by $2 per hundredweight by using an annual payment procedure. The $2-per-hundredweight payment is chosen merely for illustration. No subsidies would have been likely during a year when hog prices were as high as in 1954, unless the objectives of the program required that payments be made during times of both high and low prices.

The average weight of hogs commercially slaughtered within each state in hundreds of pounds (40, p. 326) is multiplied by $2 to estimate the average direct payment per hog. Total payments to producers in each state are estimated by multiplying the average payment per hog by the number of hogs sold (44, p. 505). This procedure is used to estimate the total cost of the payments in all states.

Regional payment totals are estimated by adding the payments that would have been made to producers in each of the states within the regions. The regional payment totals are shown in table 3 along with payment totals for Iowa and the United States.

The estimate of the total cost of the payments in table 3 shows how much it would have cost the government to give producers an arbitrarily selected payment of $2 per hundredweight. The estimate has greatest significance as a comparative device. It allows a percentage cost comparison between limited and unlimited direct-payment programs. It also allows an investigation of the effects of differences in marketing weights upon the regional allocation of the direct payments.

Estimating the limited payments

The effects of limiting the size of payments are estimated next. Payments are made in proportion to the number of hogs eligible for direct payments from each state. Payment size is again a flat $2 per hundredweight. Average payments per hog are the same as under the program that would have allowed direct payments for all hogs. The only difference between the programs is that the

Table 3. Allocation of the unlimited direct payments.

Area	Payment (dollars)	Percent of payment
New England	764,337	0.27
Middle Atlantic	3,924,831	1.37
East North-Central	93,917,113	32.79
West North-Central	145,169,210	50.68
South Atlantic	15,180,050	5.30
East South-Central	13,160,176	4.59
West South-Central	7,714,952	2.69
Mountain	2,922,697	1.02
Pacific	3,686,166	1.29
Iowa	73,444,690	25.64
United States	286,439,532	100.00

Table 4. Allocation of limited direct payments — payments limited to 100 hogs per producer, 1954.

Area	Payment (dollars)	Percent of payment	Percent of unlimited payment
New England	370,589	0.16	48.48
Middle Atlantic	3,085,959	1.35	78.62
East North-Central	71,076,502	31.10	75.68
West North-Central	114,751,351	50.20	79.05
South Atlantic	14,794,358	6.47	97.46
East South-Central	12,888,568	5.64	97.94
West South-Central	7,388,780	3.23	95.77
Mountain	2,300,110	1.01	78.80
Pacific	1,917,481	0.84	52.02
Iowa	51,200,510	22.40	69.71
United States	228,573,598	100.00	79.80

average payment per hog for producers in each state now is multiplied by the number of hogs eligible for direct payments, rather than by all hogs. It is assumed that the average weight of the subsidized hogs would have been the same as that of all hogs commercially slaughtered within each state.

Table 4 gives the payments allotted to producers in each region, Iowa and the United States under a program that would have payments limited to a basis of 100 hogs per producer.

Limiting payments to 100 hogs per producer would have reduced the cost of the program by an estimated $57,865,934, a reduction in cost of about 20 percent. Producers in the regions with the highest percentage of hogs eligible would have received a greater percentage of the total payment under the program that would have limited payments to 100 hogs per producer. The percentage increase, however, would not have been large. Producers in the South Atlantic region would have received 5.30 percent of the national payment under the program imposing no size of payment restriction. These producers would have received an estimated 6.47 percent of the national payment under the program restricting payments to 100 hogs per producer. Producers in the East South-Central region would have received 1.05 percent more of the total payment under the program imposing a 100-hog limit, as compared with the program allowing payments for all hogs.

The payments to producers in the New England and Pacific regions would have been only about half as great with the 100-hog payment restriction. Although only about 7 percent of the producers in the New England region sold over 100 hogs, these producers sold over 50 percent of the hogs. The figures in column 3 of table 4 are highly correlated with the estimated percentage of hogs eligible for direct payments from each region. The deviation from these figures can be attributed to the difference in average payments per hog. For example, producers in the Mountain region sold their hogs at lighter weights, making their average payment per hog less, and consequently, received slightly less of the total national payment than their percent of eligibility would suggest. The regional differences in marketing weights, however, had very little effect on payment allocation.

Table 5 gives the payment details for the hypothetical direct-payment program with a 200-hog payment restriction. The total cost to the government under this program would have been $267,753,861, or an estimated $18,685,671 less than the cost of the program that would have allowed payments for all hogs. This is a reduction of about 6 percent.

The cost of the program that would have allowed payments for 200 hogs per producer would have been

Table 5. Allocation of limited direct payments — payments limited to 200 hogs per producer, 1954.

Area	Payment (dollars)	Percent of payment	Percent of unlimited payment
New England	479,476	0.18	62.73
Middle Atlantic	3,246,296	1.21	82.71
East North-Central	87,368,508	32.63	93.03
West North-Central	136,452,417	50.96	94.00
South Atlantic	14,960,710	5.59	98.55
East South-Central	12,925,780	4.83	98.22
West South-Central	7,552,822	2.82	97.90
Mountain	2,434,544	0.91	83.30
Pacific	2,333,308	0.87	63.30
Iowa	66,524,887	24.85	90.58
United States	267,753,861	100.00	93.77

$39,180,263 (or about 17 percent) greater than the program that would have limited payments to 100 hogs per producer. A large part of the increase in total cost can be attributed to the greater payments that would have been required for producers in the North Central regions. Total payments to producers in these regions would have been an estimated $37,993,072 higher with payments limited to 200 hogs per producer.

Effects of a 100- or 200-Hog Limit on Production Efficiency

A direct-payment program with a 100- or 200-hog limit could have adverse effects on production efficiency in subsequent years. These adverse effects would occur if small-scale, less efficient producers were to expand output to the point where the depressing effect on prices would make production in excess of the limit unprofitable for some large-scale producers.

Figure 3 shows the hypothetical situation that producers would face in making production decisions under a direct-payment program that limited payments to a maximum of 100 hogs per producer. The example represents a situation where the support price is announced in advance.

The producer's marginal revenue curve is discontinuous at the output level of 100 hogs. For the first 100 hogs sold, the marginal revenue curve is the support price, OP_1 and, for sales exceeding this number, the marginal revenue curve is the open-market price at some
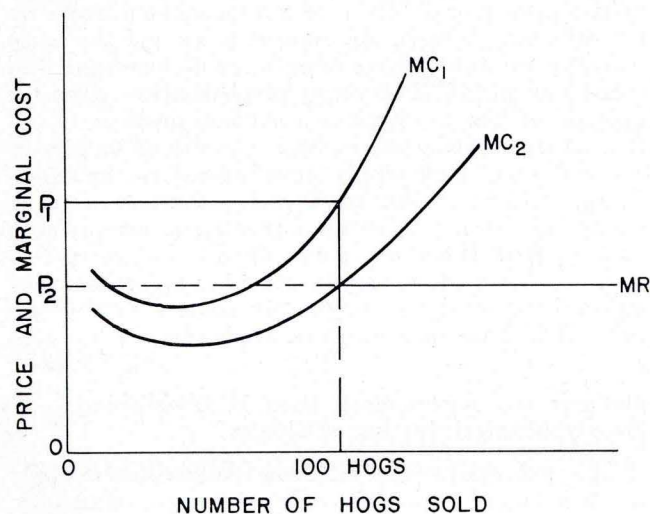

Fig. 3. Production planning under a hypothetical limited direct-payment program.

lower level, OP_2. MC_1 shows the hypothetical marginal cost curve of a producer who, before the limited direct-payment program, sold fewer than 100 hogs. If this producer were guaranteed the support price, he would increase sales to 100 hogs to maximize profit. MC_2 shows the marginal cost curve of a producer who, before the program, marketed 100 hogs. This producer would receive a greater net return for his sales because of lower production costs, but it would not be profitable for him to expand production beyond the number of hogs eligible for payments. In this hypothetical case, the less efficient producer is given an inducement to expand output, while the more efficient producer would maintain his sales at pre-program levels.

Whether the producer who marketed more than the number of hogs eligible for payments would maintain his previous level of production, or reduce production, would first depend upon his individual cost structure. Production in excess of the limit would be profitable if the marginal revenue from producing each hog in excess of the limit were greater than the marginal cost. Second, the price effects of such a program on small-scale producers may differ from the price effects on large-scale producers; e.g., as small-scale producers expand output, price drops, and this might induce large-scale producers to curtail production.

Cost estimates for various sizes of enterprises would give an indication of the differences in total resource cost that would result if small-scale producers were induced, by a limited direct-payment program, to produce a greater portion of the nation's hogs.

Estimates of the cost of production for various sizes of enterprises are rare. Purdue University, however, published some data which indicate a variation in hog production costs (3). These have some value in estimating the possible effects of a limited direct-payment program. In the Purdue study, costs and returns for various sizes of enterprises ranging from 5 to 120 sows were computed. Table 6 shows the summarized estimates of average costs and returns per hundredweight for 130 Indiana hog enterprises.

These estimates were computed from data collected during 1956 and 1957 from producers with herds of from 5 to 120 sows, all on a two-litter basis. The data were adjusted to a corn-hog ratio of 13.6 to 1 — long-time Indiana averages — with corn valued at $1.21 per bushel and hogs at $16.50, adjusted seasonally to reflect the average situation. Labor was charged at $1 per hour for all enterprises.

Figure 4 gives an approximation of the average production costs per hundredweight expressed in number of

Table 6. Costs and returns per hundredweight for various sizes of Indiana hog enterprises.[a]

Number of sows	Cost per hundredweight (dollars)	Net return per hundredweight[b] (dollars)
5-14	16.86	0.03
15-24	15.62	0.81
25-34	15.78	1.09
35-44	14.86	1.91
45-54	14.56	2.03
55-64	14.50	2.20
65+	15.21	1.62

[a]Data from Bauman and Eisgruber (3).
[b]The net returns are affected by the average variation in the prices at the different seasons of the year when the hogs were sold, as well as by the differences in costs of producing the hogs.
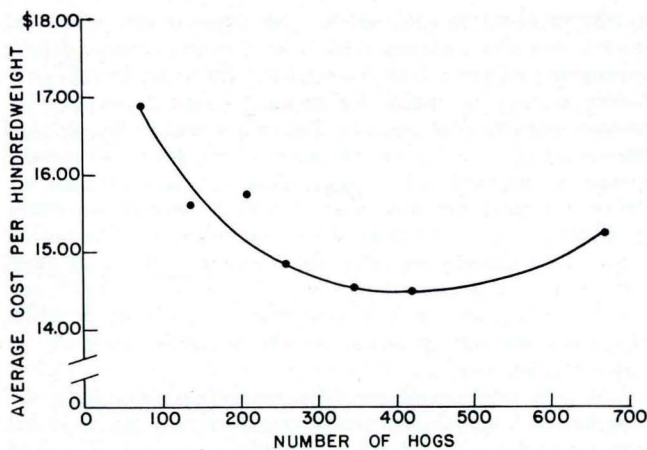
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Fig. 4. Cost of production by size of enterprise.

hogs sold. These figures represent costs for a single season's farrowings. The estimates are computed by multiplying the average number of pigs raised per litter by the average number of sows farrowed from each group.

The cost estimates are too aggregated to be of great value, but they do indicate variable proportions. Costs of production per hundredweight average $16.86 for the 5- to 14-sow herds and $14.50 for the 55- to 64-sow enterprises, a difference of $2.36.

The cost estimates indicate that neither a 100-hog nor a 200-hog yearly payment limit would encourage the most efficient size of enterprise. The lowest average costs per hundredweight are realized with about 60 sows or with sales of between 350 and 400 hogs from a single season's farrowings.

The Purdue cost estimates indicate that it would require a considerably greater amount of resources to produce the nation's hogs if small-scale producers were induced to produce a greater percentage of the hogs.

ESTIMATED EFFECTS OF PAYMENTS RESTRICTED TO MARKETING QUOTAS

In this part of the study, an alternative direct-payment program for hog producers is considered. Some of the effects of using marketing quotas for hog producers, with direct payments limited to quota marketings, are estimated. The objective of the program is to provide the nation's hog producers with a measure of income security by making direct payments on the number of hogs needed to provide a stable future pork supply whenever the yearly average price falls below a preset "support" level.

The difference between a program which would limit direct payments to quotas instead of to a uniform number (such as 100 or 200 hogs per producer) is that, under the quota system, payments would be made on a uniform percentage of each producers' previous sales — say, 90 percent.

Marketing quotas to date have been used for milk and for controlling crop production. The producers of all of the basic commodities have been subject to acreage allotments. The quota marketing of these producers was the production from their acreage allotments. Penalties of varying sizes have been imposed on marketings in excess of quotas.

A direct-payment program that would allow direct payments for the quota marketings of hog producers could take different forms. Payments could be limited to quota allotments and penalties imposed for marketings in excess of quotas. Rigid supply adjustment could be incorporated if the penalties for excessive marketings were large. Several problems, however, could arise if this procedure were followed.

Hogs, unlike wheat or cotton, cannot be stored until the next year without a change in form. Producers can only estimate the number of barrows and gilts that will be marketed from the sows they intend to farrow. Producers would have only a few alternatives if their production was in excess of the number they could market under their individual quotas. A greater number of hogs could be consumed on the farm. Increased farm consumption, however, would provide only a limited additional outlet. Hogs that could not be marketed under the quota could be retained for breeding stock for the next year. Hogs that could not be more profitably disposed of could be sold subject to the penalty.

A direct-payment program could be established with the stipulation that payments would be made for only the hogs sold under the quotas, with no penalties for marketings in excess of quotas. Producers could then market hogs in excess of their quotas if their cost structures permitted. This type of program receives primary consideration in the following study.

Announcement of the Quota

The government would have to determine the national quota about a year in advance if producers were to be given a chance to adjust production to comply with their individual quotas. It would probably require a month for the government to determine and inform producers of their individual quotas after the determination of the national quotas. Quotas would have to be announced to producers at least 11 months in advance, since the gestation period of the sow is about 4 months, and growing and finishing of the barrows and gilts would require approximately 7 months.

The intent of the quota program is to let the open-market price prevail. Then the government will make up the difference between the support price and the open-market price with a direct payment on the predetermined individual quotas. However, a problem arises when the question of how to establish a national quota is raised. If a national production quota is established to provide a stable future pork supply, time becomes an important factor. Producers must know their quotas at least 11 months in advance to adjust farrowing to comply with these quotas. Therefore, pork supplies for the period in which the quotas apply would have to be estimated on the basis of statistics available about a year in advance of the time when the quotas are in effect.

Methods and Assumptions Used in Establishing the Hypothetical System of Quotas

A hypothetical system of quotas is established to apply to 1959 United States hog marketings. For simplicity, estimates of the effects of these quotas are made on an aggregated regional basis.

The methods and assumptions used in establishing the quotas are:

(a) The quotas apply to all hogs.

(b) The marketing period for which the quotas apply is Jan. 1, 1959, through Dec. 31, 1959.

(c) Pork supplies for 1959 are estimated from pork supply and distribution data available at the end of 1957 to simulate conditions that would have been encountered if a system of quotas had been in force at that time.

(d) Estimated pork supplies for 1959, in pounds, are converted to a national marketing quota by dividing the pork-supplies figure by the average pork production per hog during a historical period.

(e) The quotas are assumed to have been issued to producers by Feb. 1, 1958.

(f) Quota allotments are issued on the basis of historical marketings during a base period. As an alternative, a base period adjusted for regional trends in marketings is used.

Estimating 1959 Pork Supplies

United States pork supplies for 1959 are estimated, with one exception, on the basis of statistics available at the end of 1957. The one exception is a population estimate that would not have been available at that time but which could easily have been projected.

The following formula is used to estimate total pork supplies for 1959: (Projected trend of civilian per-capita pork consumption × civilian population as estimated for July 1, 1959) + (estimated military requirements) + (estimated ending stocks) — (estimated net imports) — (estimated beginning stocks) — (estimated farm slaughter) = total estimated 1959 pork supplies.

The trend in per-capita pork consumption from 1946 through 1957 is projected to 1959. The 1946 through 1957 period is selected to approximately reflect recent consumption patterns. Denoting civilian per-capita pork consumption by Y and time by X, the regression equation used to project civilian per-capita pork consumption to 1959 is:
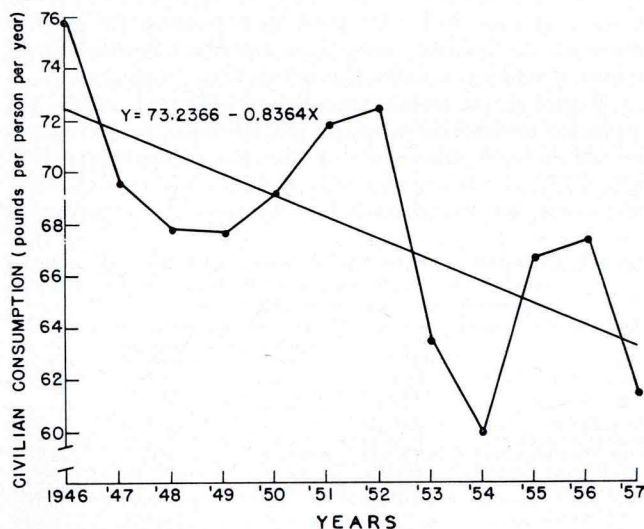
$$Y = 73.2366 - 0.8364X.$$

Fig. 5. Civilian consumption of pork per capita, 1946 through 1957, and the mathematically fitted trend line.

The trend value, —0.8364 pound per capita per year, is significantly different from zero at the 5-percent level. Figure 5 shows pork consumption per capita from 1946 through 1957 and the mathematically fitted trend line.

A July 1, 1959, population estimate (43) is used to approximate the average population for the year. Military requirements for pork during 1959 are estimated, assuming continued peace with approximately the same number of people serving in the armed forces as in 1957. Therefore, the armed forces pork requirements for 1959 are approximated by the 1957 figure (35, p. 285).

Estimates of 1959 beginning and ending stocks, net imports and farm slaughter are simply the averages of these quantities for the 4-year period, 1954 through 1957 (35). The magnitude of these quantities tends to show some variation according to the stages of the hog cycle. An average of these quantities over the previous hog cycle is used to approximate the magnitude of these quantities for 1959.

Upon substitution of the values into the equation, the estimated 1959 pork supplies = (61.53 pounds × 174,-566,000) + (213 million pounds) + (336 million pounds) — (35.25 million pounds) — (369 million pounds) — (935.87 million pounds) = 9,949,152,282 pounds.

The 1959 pork supplies estimate is converted to a national marketing quota in terms of hog numbers by dividing by 134 pounds — the average production of pork, excluding lard, per hog commercially slaughtered during the 1954 through 1957 period (35, p. 196).

Average production of pork per hog is related to factors affecting the live weight of hogs marketed. Some of these factors are the supplies of feed grain available for fattening, the hog-corn ratio during the fattening period and the size of the current pig crop. An average of pork production per hog for the duration of a hog cycle (1954 through 1957) provides an estimate of what the average production of pork per hog might have been in 1959.

Apportioning the Quotas

The estimated national marketing quota for United States hog producers in 1959 is 74,274,405 hogs. This quota is first distributed among producers in the nine regions on the basis of historical marketings. The historical marketing base period is 1954 through 1957. Average hog marketings over the period were 74,161,500 per year (40, 41, 42). The average marketings during the base period are 0.12 percent less than the estimated national quota for 1959. The consumption and supplies estimation procedure used to establish the quota results in a quota very near the average marketings over the 4-year hog cycle.[6]

The 1954 through 1957 base period, used to apportion the quotas, began 5 years before the year for which the quotas apply. When quotas are assigned on the basis of marketings during a base period, producers are apportioned quotas according to their relative marketings during this period. This system tends to project the geographical marketing patterns of the past into the future. A method of apportioning quotas to take marketing trends into

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[6]The nature and effects of the annual variations behind the 4-year cycle are discussed later in this report.

account would adjust producer allotments to the changes in geographical marketing patterns.

An as alternative basis for quota allocation, the 1954 through 1957 marketing base is modified to estimate how quota allotments and direct payments by regions are affected by including marketing trends. A modified base is computed for each region with a significant marketing trend. The modified base is computed by adding to, or subtracting from, the 1954-57 base the trend value in marketings to approximate the expected increase or decrease in marketings during 1958 and 1959, assuming a continuation of the 1946 through 1957 trends in regional hog marketings (39, 40, 41, 42). For example, to compute the marketing base for producers in the Pacific region, $2 \times 25,790$ or 51,580 hogs are subtracted from the 1954-57 marketing base. The 51,580 hogs constitute the expected decrease in marketings during 1958 and 1959. In the regions where the marketing trends are not significantly different from zero, the 1954 through 1957 base is again used to apportion the quotas.

Producers in the regions with significant positive marketing trends are allotted additional hogs under the modified base. Producers in the regions with insignificant or negative marketing trends are allotted fewer hogs after the reapportionment.

Estimated Payments

Estimates now are made of the payments that would have been made to producers under a direct-payment program for quota marketings in 1959. The magnitude of the payments would have been primarily dependent upon the level of the support price, the percent of producer participation, and the percent of participating producers who would have marketed their full quota allotments.

The support price used is 80 percent of the United States average price of hogs for the 10-year period, 1949 through 1958 (35, 36). The payment procedure is similar to that used by the Canadians under their deficiency-payment program. A payment estimate is made assuming that the government would have made up to each producer, for his quota marketings, the difference between the 1959 United States weighted-average market price and the support price. Additional assumptions made in the computation of the payment estimates are: (a) there would be 100 percent producer participation; (b) each producer would have marketed his full quota allotment; and (c) marketings would have been unaffected by the direct-payment program. The last assumption implies that producers simply would have taken their chances on the open market for marketings in excess of their quotas.

The estimated weighted-average price of hogs in the United States was $14.07 per hundredweight in 1959. The hypothetical support price is $14.70 per hundredweight. The support price is 80 percent of the average price received by farmers for hogs from 1949 through 1958. Payments would have been 63 cents per hundredweight for all hogs sold under quotas.

The procedure used to establish the national pork quota for 1959 and the procedure used for developing the support price are not entirely consistent. With the exception of the per-capita pork consumption estimate for 1959, which is based on the 1946 through 1957 trend, the balance of the components used in establishing the 1959 national pork quota is based on the historical relation-

ships in the 1954 through 1957 period. The support price, however, is set at a specific percentage of the average price received by farmers for hogs from 1949 through 1958.

In light of recent technological advances in hog production, this inconsistency could generate built-in pressures to maintain an economically unsound program. For example, the many small-scale producers might operate on a higher price and cost level than the few large-scale producers (3). The latter producers could pose a constant threat to the small-scale producers. These possible treadmill effects would need to be considered when establishing the national pork quota and the support price because of the additional difficulties they could pose to the effective administration of such a program.

However, for the purpose of comparison with the same type of support price used by the Canadians, 80 percent of the 1949 through 1958 average price is used as the support price. Estimates are made of the total payments that would have been required for producers in each of the nine regions. In the estimation process, the simple average weight (36) of the hogs marketed within each region is multiplied by the difference between the support and the weighted-average market price. This provides an estimate of the average payment that would have been required for each hog marketed under quotas by producers in each region. Total regional payments are estimated by multiplying the average payment per hog by the estimated number of hogs eligible for direct payments from each region. It was necessary to assume that the hogs marketed under the quotas would have had an average weight equal to the average for all hogs marketed within the regions.

Estimates are made of the total payments that would have been required under both methods of apportioning the quotas. Regional payments in 1959, under the assumed payment procedures, would have been as indicated in table 7.

The total payments would have been approximately the same, regardless of the method used to apportion the quotas. This is logical since the total number of hogs eligible for direct payment would have been the same for both allocation methods. Total payments would have been slightly greater if the 1954 through 1957 historical marketing base had been used to apportion the quotas. More of the heavier hogs from the West North-Central region would have been eligible for direct payments.

Regional payments would have differed under the alternate methods of apportioning the quotas. Producers in the West North-Central region would have received a $1,135,551 greater payment if the 1954 through 1957 historical marketing base had been used to apportion

Table 7. Regional payments and the percent of the total payment received by producers in each region under alternate methods of quota allocation, 1959.

Area	Payments, 1954-57 base (dollars)	Percent of payment	Payments, modified base (dollars)	Percent of payment
New England	253,220	0.23	247,952	0.23
Middle Atlantic	1,326,515	1.21	1,388,206	1.27
East North-Central	36,718,460	33.60	37,294,350	34.16
West North-Central	54,594,551	49.96	53,459,000	48.96
South Atlantic	5,824,316	5.33	6,228,374	5.71
East South-Central	5,336,335	4.88	5,609,743	5.14
West South-Central	3,226,641	2.95	3,159,527	2.89
Mountain	935,913	0.86	820,314	0.75
Pacific	1,071,452	0.98	980,902	0.89
Total	109,287,403	100.00	109,188,368	100.00

the quotas. Payments for producers in the East North-Central region would have been $575,890 greater under the modified base than under the 1954-57 historical marketing base.

Cost of Unlimited Payments

Costs incurred under the quota program now are compared with those for a direct-payment program for all hogs at the same rate of payment per hundredweight. The estimated cost by regions and for the United States of unlimited direct payments for all hogs marketed during 1959 is shown in table 8.

Producer participation in the program is assumed to be 100 percent. A 63-cents-per hundredweight direct payment is used to raise the $14.07 national average price received by farmers for hogs sold during 1959 to the $14.70 support level. The unlimited payments are computed by multiplying the difference between the support and the market price of hogs by the total liveweight of hog marketings in each region in hundreds of pounds.

Direct outlays for the unlimited payments would have been $124,425,316 and about 12 percent greater than the payments for the quota marketings.

The Use of Quotas for Supply Control

In the preceding program, direct payments are made only for the hogs needed to provide a stable future pork supply. Producers who marketed hogs in excess of their quotas simply received no direct payments for their excess marketings.

A rigid supply control system of quotas would be very difficult to use effectively for hogs. A program that would allow producers to market only their quota allotments would probably necessitate the destruction of some of the over-quota production. Public resentment arose when this procedure was followed during the depression and probably would arise again if the practice were repeated. Even if the number of hogs marketed could be restricted to the quota, the program might not reduce greatly the total pork tonnage, since producers might be induced to market their hogs at heavier weights.

An estimate of the possible effects of a rigid supply control measure can be made if the unrealistic assumptions are made that marketing weight would not have changed as a result of the program and that marketings could have been restricted to the quotas. The quota for 1959 called for a reduction in numbers of 10,149,595 below the actual marketings. If marketing weights would not have changed because of the program, total hog marketings would have been reduced by 23,750,052 hun-

Table 8. Estimated cost of unlimited direct payments for all hogs marketed during 1959.

Area	Payment (dollars)	Percent of payment
New England	272,242	0.22
Middle Atlantic	1,120,846	0.90
East North-Central	40,670,135	32.68
West North-Central	62,199,585	49.99
South Atlantic	7,317,261	5.88
East South-Central	6,470,705	5.20
West South-Central	3,864,653	3.11
Mountain	1,183,638	0.95
Pacific	1,326,251	1.07
United States	124,425,316	100.00

Table 9. Actual 1959 and hypothetical quota marketings, prices and value of marketings.

	Marketings (hundreds of pounds)	Price per hundredweight (dollars)	Value of marketings (dollars)
Actual 1959	197,500,500[a]	14.07	2,778,832,035
Quota 1959	173,750,448	18.30	3,179,633,198

[a]Taken from U. S. Department of Agriculture (36, p. 34).

dredweight — a reduction of 12.03 percent (refer to table 9).

An estimate of the elasticity of demand for hogs at the farm level, —0.4 (24, 29, p. 19), is used to estimate the effect on hog prices that a 12.03-percent reduction in the quantity of marketings would have had during 1959. The figures in table 9 can be used to compare the actual value of the hog marketings during 1959 with the marketings called for under the restrictive quota.

The value of the smaller quota marketings is 11.4 percent greater than the actual value of hog marketings during 1959.

Effects of Marketing Quotas on Production Efficiency

A program that would not penalize producers for marketing in excess of quotas probably would have little negative or positive effect on production efficiency. Some positive effect could be realized if the program provided a better basis for production planning than the open market. However, the program could not be expected to remove a great deal of price uncertainty from hog production, since with the annual payment procedure, producers would not know the size of the direct payment per hundredweight until the end of the year.

A system of quotas could retard resource mobility in hog production. Small, inefficient producers might be induced to remain in hog production as long as direct payments would be made for their quota allotments. A system of quotas, however, would not be as likely to encourage smaller enterprises as would a 100- or 200-hog limit.

ESTIMATED EFFECTS OF PAYMENTS RESTRICTED TO LIGHTWEIGHT HOGS

Direct payments on hogs could be restricted to lightweight barrows and gilts, say from 180 to 200 pounds. If these direct payments on lightweight hogs induced marketings at lighter weights, the total tonnage going to market would be reduced. This would increase hog prices and total returns as well, since the demand for hogs is inelastic.

But a problem would arise. The price differentials between light and heavy hogs would change as the percentage of light hogs in the run increased. This would offset part or all of the direct payment.

Under free-market conditions, the difference between the prices of different weights of hogs results from the relative supply and demand for hogs in the various weight groups. Making direct payments on 180-200 pound barrows and gilts would induce producers to market more of their hogs below 200 pounds. Then the price differentials between the different weight groups would change.

The prices of the lighter hogs would decline relative to the prices of heavier hogs. This would offset part of the direct payment on the lighter hogs. It also would reduce the inducement to market hogs at lighter weights.

Effects on 180-200 Pound Hogs

If the direct payments on 180-200 pound barrows and gilts were large enough to induce farmers to market all of their barrows and gilts at or below 180-200 pounds, that would reduce the average weight of barrows and gilts from the 226 pounds that they averaged at eight markets combined, 1954-60, to about 190 pounds. This would reduce the total tonnage of barrows and gilts by about 15 percent.

This reduction of total tonnage of pork probably would occur only in the short run. If this type of program continued over an extended period of time, farmers could adjust their production plans and send more hogs to market thus offsetting the drop in total tonnage achieved by lighter weight marketings.

But the payment would have to be quite large to bring about this 15-percent reduction, for reasons given in the rest of this section. Figure 6 shows the relationship between two variables: (a) the *ratio* of the percentage of hogs marketed at 200 pounds and under to the percentage of 240-270 pound hogs marketed and (b) the *price differential* between 180-200 and 240-270 pound hogs for the 4-year period, 1956-59.[7] This period covers one full hog cycle.

Using the 4-year average for Chicago, we find that, as the relative percentage of lightweight hogs in the receipts increases, the price differential between the lighter and heavier weight groups decreases and then becomes negative (see fig. 6). During this period, an increase of one in the receipts ratio between light and heavy hogs is associated with about an 80-cent drop in the price differential.

If a direct-payment plan for 180-200 pound hogs increased the number of hogs coming to market at 180-200 pounds, it would depress the relative price of 180-200 pound hogs at a rate of about 80 cents for an increase of one in the ratio. This would wipe out some of the effectiveness of the payments.

Suppose, for example, that an increase of one in the ratio between light and heavy hogs resulted from a direct payment of $1 per 100 pounds on lightweight hogs. In this case, 80 cents of the $1 would be offset by the change in the market differential against it.

The system, thus, would be self-equilibrating. To the extent that a payment for marketing hogs at lighter weights was successful — inducing marketings of more hogs at lighter weights — the relative price of the lightweight hogs would decrease and nullify part or perhaps all of the payment. Then the incentive to market hogs at lighter weights would decrease to a point where a new equilibrium would be reached.

Effects of 4-year cycle

The 4-year average shows that, as the percentage of lightweight hogs increases, the price differential between 180-200 pound and 240-270 pound barrows and gilts declines or even becomes negative. It is possible that this relationship varies, depending on the total supply of barrows and gilts on the market. That is, it may vary depending on the stage of the hog cycle. Since this type

[7]The data in figs. 6 through 9 are available in tabular form from the senior author.

Fig. 6. Relationship of the ratio of percentage of hogs 200 pounds and under and percentage of hogs 240-270 pounds to the price differential between 180-200 and 240-270 pound hogs, at Chicago, monthly averages, 1956-59.

of direct payment might be used only when supplies are large, it is desirable to determine whether the relationship in short supply periods is different from that in large supply periods.

Table 10 shows the salable receipts of all hogs at the 12 major public stockyards, salable receipts of all hogs at Chicago, percent of barrows and gilts in the Chicago receipts and the salable receipts of barrows and gilts at Chicago for each of the years 1956-59. The effect of variation in total receipts on the relationship between ratios of percentage receipts and price differentials is shown in the diagrams in fig. 7. They show the relationship separately by years, 1956 through 1959.

Table 10. Salable receipts of all hogs and barrows and gilts for Chicago and other markets, 1956-59.[a]

	1956	1957	1958	1959
Salable receipts of all hogs for 12 public stockyards (head)	18,336,257	16,112,434	15,651,617	18,448,905
Salable receipts of all hogs for Chicago (head)	2,416,102	2,028,739	2,073,594	2,234,920
Approximate percentage barrows and gilts of all hogs at Chicago	83	83	86	86
Salable receipts of barrows and gilts at Chicago (head) (row 2 times row 3)	2,005,365	1,683,853	1,783,291	1,922,031

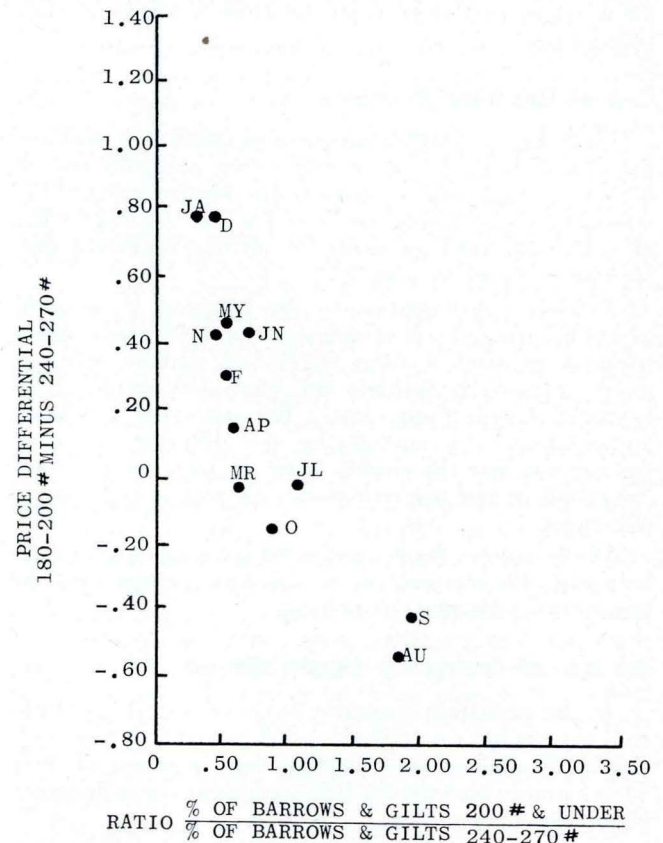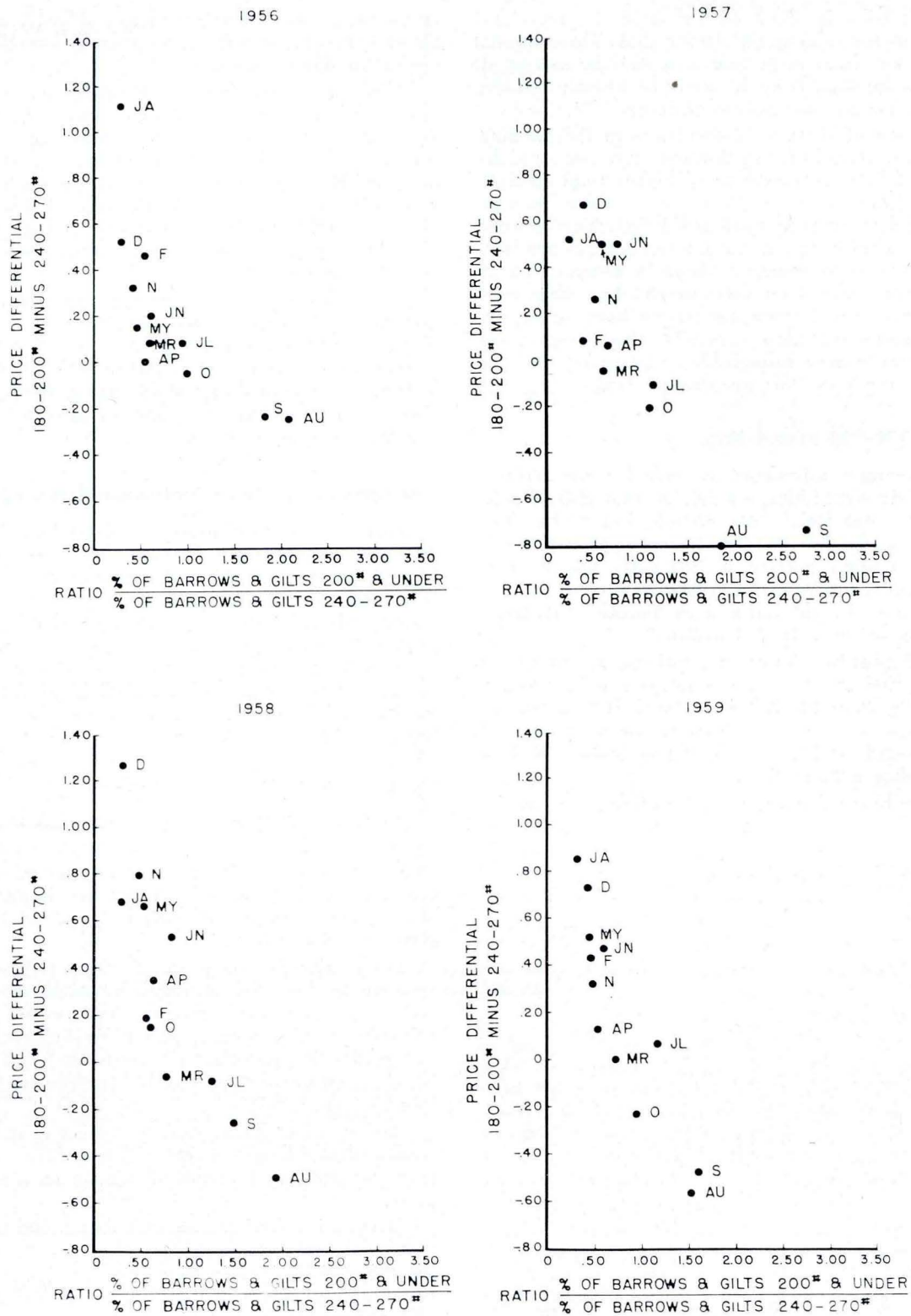[a]Basic data from U. S. Department of Agriculture (36).

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Fig. 7. Relationship of the ratio of percentage of hogs 200 pounds and under and percentage of hogs 240-270 pounds to the price differential between 180-200 and 240-270 pound hogs, at Chicago, separately by years, 1956-59.

The regression is about $1 for 1956, 60 cents for 1957, 80 cents for 1958 and $1.10 for 1959. These results are reached by visual inspection of a straight line fitted free-hand to the dots. It could easily be argued that the relationship is curvilinear instead of linear.

Comparison of these relationships with the receipts at Chicago for 1956-59 shows that the regression is higher ($1 and $1.10) in the years of higher total receipts (1956 and 1959) than in the years of lower receipts (60 cents and 80 cents in 1957 and 1958). This is what one would logically expect, since, when receipts are low, buyers are forced to purchase "hogs in general," so to speak, with less regard for their weight than when supplies are heavier and when the buyers have an opportunity to discriminate more carefully. The buyers alone are not the only ones responsible; consumers, and the rest of the marketing system, are also involved.

Effects on 180-220 Pound Hogs

On the average, only about 15 percent of the barrows and gilts marketed at Chicago weigh less than 200 pounds. About 40 percent weigh 220 pounds and under. The price differentials for 180-200 pound hogs are sensitive to even a small increase in their percentage of total receipts. What would happen if a broader — and perhaps less sensitive — weight range were included for direct payments, for instance 180-220 pounds?

Figure 8 presents the same relationship and covers the same period as fig. 6. But a broader weight range, *180-220* rather than 180-200, is included for lightweight hogs, so the receipts ratio is between the percentage of hogs *220* pounds and under and the percentage of 240-270 pound hogs in the receipts.

With the broader range for lightweight hogs, an in-crease of one in the receipts ratio is associated with only about a 30-cent decline in the price differential between the light and heavy hogs.

Thus, direct payments on 180-220 pound hogs would not disturb market receipts and price relationships as much as payments on 180-200 pound hogs. There also would be, of course, less reduction in total weight of the hog slaughter. Payments on 180-220 pound hogs, could, at a maximum, reduce the total weight of hog slaughter about 6 percent in the short run — reducing the overall average weight of barrows and gilts from about 225 pounds to nearer 210.

Again this is a 4-year average approach. Inspection of years individually shows much the same result as indicated for hogs under 200 pounds (see fig. 9). The regressions by years are about 40 cents in 1956, 15 cents in 1957, 30 cents in 1958 and 50 cents in 1959. This again shows the larger value of the regression coefficient for the two years of larger receipts.

Determination of Most Profitable Marketing Weight

Farmers have been urged to market their hogs below 230 pounds, but many farmers feed them to weights beyond 230 pounds. Why? Do they make more money? If so, then why are farmers urged to market below 230 pounds? Is this not asking the individual to sacrifice profits so that the group may benefit? Or would the decline in total tonnage of pork raise hog prices enough to more than compensate the individual for losses of income that would have been received from selling at heavier weights?

USDA research

Atkinson and Klein (1) recorded some work done in 12 experiments in five Corn Belt states. They state that "the feed-and-gain data from the 12 experiments showed that, as the weight of a hog increases, larger quantities of feed are consumed per unit of gain, but less than is generally recognized" (1, p. 22).

Daily gain increases rather rapidly from date of weaning to the point at which a weight of more than 100 pounds is reached; then the increase is a little more gradual, reaching a maximum of 1.71 pounds per day in the 200-210 pound weight range; but the daily gain is only 10 percent less at both 160 pounds and 300 pounds (see fig. 10) (1, p. 3).

Atkinson and Klein used feed units to measure feed consumed at different weights. They defined "feed units" as a unit equal to 1 pound of corn in feeding value (1, p. 8).

When this criterion was used, they found that 10 percent more feed is consumed per 100 pounds weight gain for the 225-275 pound hogs than for hogs up to 225 pounds. Hogs marketed at the 200-pound level consume ½ of 1 percent less feed units per 100 pounds of liveweight than do hogs marketed at 225 pounds. Atkinson and Klein (1, pp. 8-9) state that hogs marketed at 250 pounds require 1 percent more feed units, that hogs at 275 pounds require 2 percent more feed units and that hogs at 300 pounds require 3 percent more feed units per 100 pounds of liveweight than do the 225-pound hogs (refer to table 11).
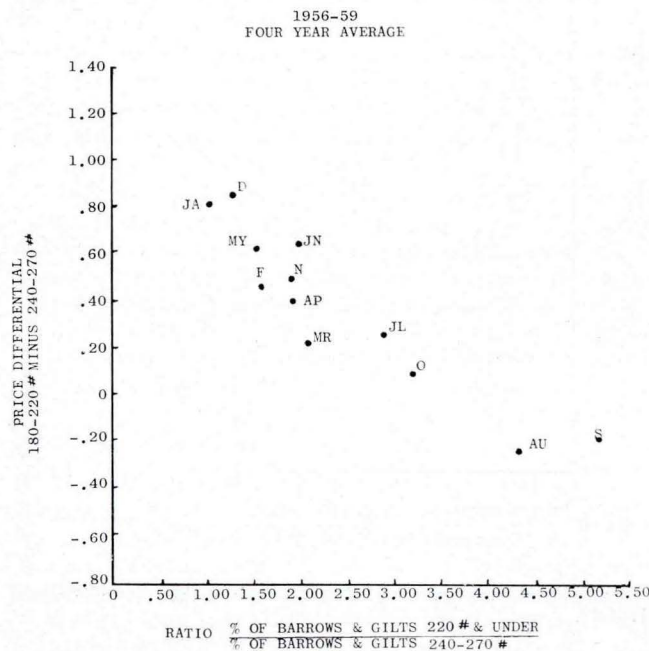

1956–59
FOUR YEAR AVERAGE

Fig. 8. Relationship of the ratio of percentage of hogs 220 pounds and under and percentage of hogs 240-270 pounds to the price differential between 180-220 and 240-270 pound hogs, at Chicago, monthly averages, 1956-59.
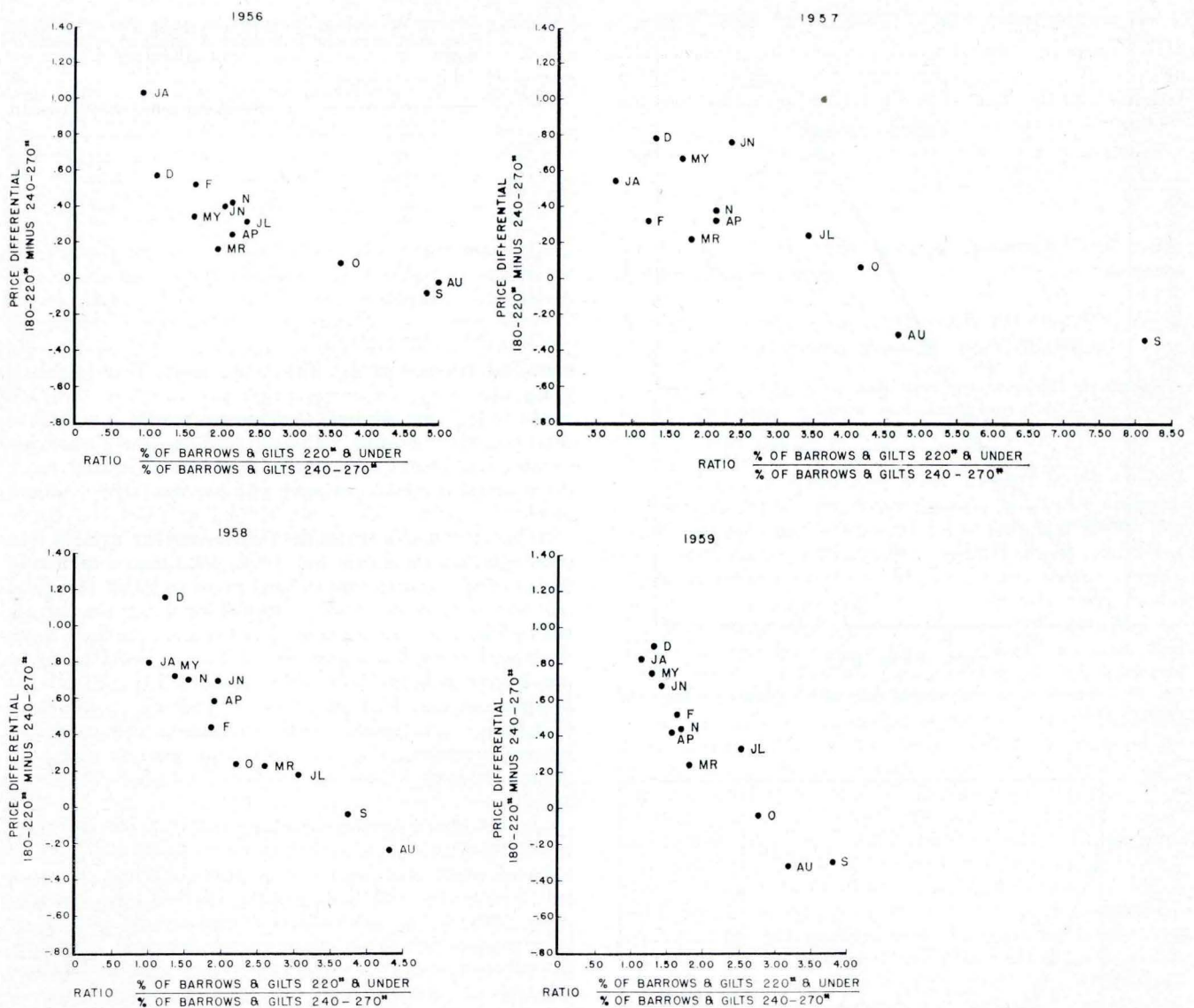
Fig. 9. Relationship of the ratio of percentage of hogs 220 pounds and under and percentage of hogs 240-270 pounds to the price differential between 180-220 and 240-270 pound hogs, at Chicago, separately by years, 1956-59.

Estimates of most profitable marketing weights for 1955 through 1958 using average yearly prices

In determining the most profitable marketing weight, comparisons are made between the cost of keeping the hog for a given period and its increase in value during the period. Specifically, this is return over variable costs, but, for the purpose of brevity, it will be referred

Table 11. Feed consumption for specified gains in liveweight per 100 pounds gain.[a]

| Change in weight of butcher hog (pounds) | Concentrates consumed per 100 pounds gain | | | |
| | | | Index numbers (225-pound hog = 100) | |
	Feed units	Pounds	Feed units	Pounds
200-225	489	448	104.2	109.0
225-250	506	470	108.0	114.3
250-275	528	496	112.6	120.6
275-300	552	523	117.8	127.3
200-250	497	459	106.1	111.7
225-275	517	483	110.3	117.4
250-300	540	509	115.2	123.9
200-300	519	484	110.6	117.8

[a]Data from Atkinson and Klein (1, p. 8).

to simply as "profit" in the following sections. The weight gains and amount of feed needed for those gains are taken from Atkinson and Klein's figures on feed consumption and weight gains (refer to table 12). These figures are adjusted to the United States Department of Agriculture weight classifications. To determine costs of feeding, a ration is formulated which includes corn, meat scraps and soybean meal in proportions that make up a 10-percent protein feed. The 1955-58 average yearly feed prices (31) are used to determine the costs of feeding. From this, marginal costs are determined. Marginal revenues are determined by the use of average yearly hog prices (35, 36) for 1955-58 on the Chicago market; these are multipled by each of the weight groups. The difference between the values of the various weight groups constitutes the marginal returns.

Using average yearly prices for hogs and feeds, the optimal (most profitable) marketing weight in 1955 was about 240 pounds, since marginal cost exceeds
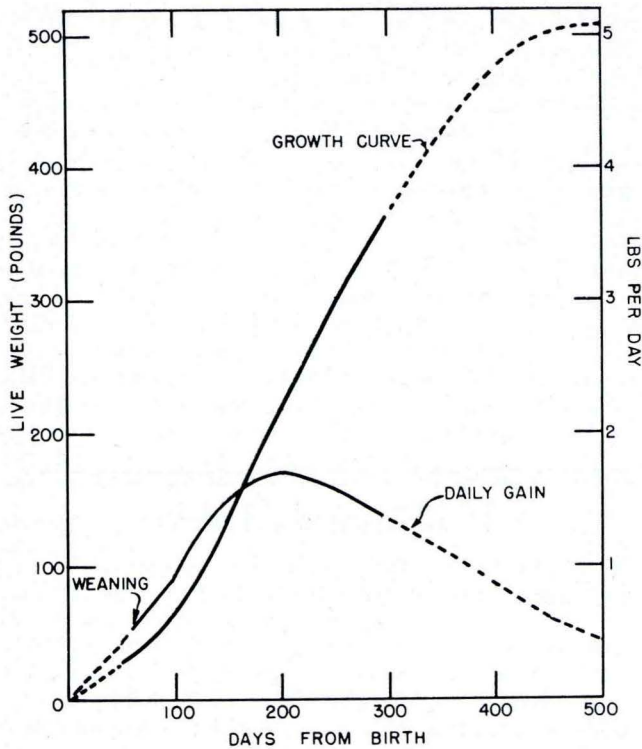
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Fig. 10. Growth curve and rate of daily gain of hogs. Atkinson and Klein (1, p. 4).
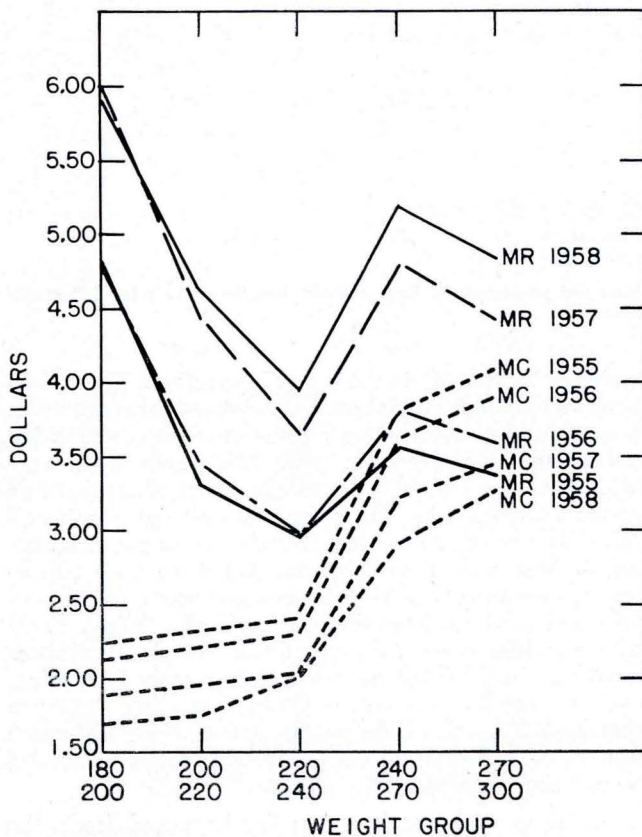

Fig. 11. Marginal revenues and marginal costs computed with average yearly prices, 1955-58.

Table 12. Relationship of feed consumed by hogs after weaning to liveweight, measured both in feed units and in pounds of feed.[a]

Liveweight	Feed consumed after weaning		Rate of gain in liveweight per additional 100 pounds of feed in pounds
	Feed units	Pounds	
35	0	0	......
50	64.7	50.7	29.3
75	172.8	137.5	28.2
100	281.8	227.8	27.2
125	392.1	321.7	26.1
150	504.5	419.6	25.0
175	619.5	521.7	23.9
200	737.7	628.5	22.9
225	859.8	740.6	21.8
250	986.3	858.1	20.7
275	1,118.3	982.0	19.6
300	1,256.3	1,112.8	18.6

[a]Data from Atkinson and Klein (1, p. 25).

marginal revenue at the 270-pound level. This is shown in fig. 11.

In 1956, the optimal marketing weight was about 270 pounds, because, at 300 pounds, marginal cost exceeded marginal revenue. In the years 1957 and 1958, the optimal marketing weight was beyond the 300-pound level.

The marginal revenue in all five weight groups was relatively low in 1955 and 1956, but it was relatively high in 1957 and increased even more in 1958. Marginal cost declined from 1955 through 1958; this can be explained by lower feed prices. For example, soybean meal decreased from $4.33 per 100 pounds in 1955 to $4.14 per 100 pounds in 1958 (refer to table 13) (34). So it is apparent that both effects were working in the same direction — marginal costs decreased, and marginal returns increased. This was true from year to year with the exception of 1958 when prices of feed grains increased again.

In the above analysis, average yearly prices are used to determine optimal marketing weights. We will look at seasonal price variation to see what effect it has. Atkinson and Klein observed that, during 1930-41, the seasonal price pattern was quite stable except during periods of price control or when a sharp change occurred. This does not mean that price movements in any year will follow the seasonal pattern, but, over periods of 5, 10 or 20 years, the seasonal changes are very similar (1, p. 10). However, it was found in this study that, during the period 1947-59, the seasonal price pattern did change. Price patterns for years 1930-41 are shown in table 14. Price patterns for years 1947-59 are shown in table 15, which is based on R. J. Foote's and Karl A. Fox's (20) article and on a bulletin by Breimeyer and Kause (5).

For the period, 1947-59, highest prices occurred dur-

Table 13. Feed prices by years (in dollars).[a]

	Average yearly prices			
	1955	1956	1957	1958
Corn No. 3 yellow[b] (bushels)	1.35	1.29	1.12	1.07
Soybean meal (hundredweight)	4.33	4.01	3.80	4.14
Meat scraps (hundredweight)	5.03	4.73	4.71	5.80

[a]Data from (31).
[b]U. S. average price received by farmers on 15th of month.

Table 14. Index numbers of seasonal variation in prices for 200-220 pound good and choice barrows and gilts in Chicago for years 1930-41.[a]

Month	Index number	Month	Index number
Jan.	93.2	July	109.0
Feb.	97.4	Aug.	112.2
Mar.	100.0	Sept.	112.9
April	97.1	Oct.	100.7
May	96.8	Nov.	92.0
June	100.3	Dec.	88.4

[a]Data from Atkinson and Klein (1, p. 10).

Table 15. Index numbers of seasonal variation in prices for 180-200 pound, 200-220 pound, 220-240 pound, 240-270 pound good and choice (or U.S. No. 1, 2 and 3) barrows and gilts at Chicago, 1947-59 average.

Month	Index numbers[a]				Month	Index numbers[a]			
	180-200	200-220	220-240	240-270		180-200	200-220	220-240	240-270
Jan.	96.5	95.6	94.8	93.6	July	110.2	110.4	110.3	109.6
Feb.	96.6	96.5	96.0	95.4	Aug.	107.5	108.7	109.5	110.4
March	96.9	97.2	97.3	97.5	Sept.	102.3	103.4	104.6	106.3
April	97.4	97.6	97.6	97.7	Oct.	95.8	96.0	96.7	98.1
May	103.3	103.2	102.9	102.4	Nov.	90.7	90.1	90.1	90.5
June	107.9	107.7	107.4	106.5	Dec.	93.1	92.2	91.4	90.3

[a]Percentage of each weight group's moving average.

ing June, July and August when marketings were light, while for the period, 1930-41, highest prices were attained during July, August and September. The price breaks in October when spring pigs are marketed, and for the period, 1947-49, it normally reached the low point for the year in November. During the period, 1930-41, the low point was reached in December and occasionally in January. When the 1947-59 data are used, prices rise gradually through July, with no peak or low point realized in late winter and early spring. Previously a late winter peak and an early spring low point were realized.[8] Atkinson and Klein (1, p. 10) indicate that during 1930-41, a peak was reached in March and a low point was realized in April and May. On the average, hogs marketed in July, August and September, brought a price 20 percent per hundredweight higher than the price for hogs sold in November, December and January. This was true for both periods, 1930-41 and 1947-59.

Atkinson and Klein (1, p. 11) state that "normally hogs marketed within the marketing range, 200-240 pounds, sell for higher prices than heavier or lighter weights." Atkinson and Klein show that price discounts for heavier hogs vary considerably from month to month. This also holds true for the period, 1947-59 (refer to table 15). Part of this results because price changes come first for the lightest hogs. The changes are delayed for heavy hogs. "Prices of lightweight barrows and gilts, in a normal year, nearly hit their peaks by July, and, by early fall, are declining fast. Prices of heavy barrows hold high longer and usually do not break sharply until October" (5, p. 13). The reason for the delayed price movements for heavier hogs is that more time is required

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[8]Breimeyer and Kause (5, p. 13) indicated that the prices for years 1947-53 rose to a secondary peak about late winter and then declined briefly before substantial increases in the price of hogs occurred.

for feeding them, thus causing marketings and price changes to appear later.

Estimates of most profitable marketing weights for 1957 and 1958 using average monthly prices

To more fully take into account seasonal price variations, marginal returns and marginal costs are computed by months for 1957 and 1958. On the basis of the data in table 16, it was profitable to carry hogs up to and above the 300-pound level for each of the months in 1957. In 1958, it was again profitable to carry hogs up to and beyond the 300-pound level for each month except December. In December, marginal cost exceeded marginal revenue at the 240-270 pound weight group; therefore, the optimal marketing weight was 240 pounds. The data show that marginal revenue fluctuates considerably more by months than does marginal cost. The reason for this is that the prices of feed do not fluctuate as much during the year as do hog prices.

As for variation of marginal revenue between months in 1957, the 180-200 pound weight group shows a marginal revenue of $7.74 in August and $5.24 in January. This is a difference of $2.50. In the 200-220 pound classification, marginal revenue ranges from $5.76 in August to $3.72 in January, a differential of $2.04. In the 220-240 pound classification, marginal revenue ranges from a high in August of $4.60 to a low in November of $3.31, a differential of $1.29. In the 240-270 pound classification, the high marginal revenue is $6.33 in August, the low is $4.09 in December and May. The greatest differential in marginal cost is at the 270-300 pound weight group which shows a difference of 50 cents from January through December. The results in 1958 are similar, as shown in table 16.

If marginal revenues and marginal costs were com-

Table 16. Marginal returns and marginal costs for various hog weight-groups by months for years 1957 and 1958 (in dollars).

Month and year	180-200 lbs.		200-220 lbs.		220-240 lbs.		240-270 lbs.		270-300 lbs.	
	MR	MC	MR	MC	MR	MC	MR	MC	MR	MC
1957										
Jan.	5.24	2.19	3.72	2.27	3.32	2.37	4.34	3.74	4.27	4.00
Feb.	5.43	2.11	4.08	2.19	3.40	2.29	4.26	3.61	4.41	3.86
March	5.61	2.12	4.20	2.20	3.47	2.29	4.55	3.62	4.41	3.87
April	5.89	2.13	4.31	2.21	3.57	2.31	4.57	3.64	4.52	3.89
May	5.99	2.18	4.19	2.26	3.35	2.36	4.09	3.72	4.21	3.98
June	6.15	2.16	4.70	2.24	3.53	2.34	4.32	3.69	4.21	3.94
July	6.76	2.18	5.20	2.27	4.21	2.36	5.46	3.73	4.69	3.99
Aug.	7.74	2.15	5.76	2.24	4.60	2.33	6.33	3.68	5.37	3.94
Sept.	7.22	2.08	5.00	2.17	4.28	2.26	6.04	3.57	......	3.82
Oct.	5.19	1.99	4.13	2.07	3.50	2.16	4.99	3.40	......	3.64
Nov.	5.43	1.93	3.77	2.01	3.31	2.10	4.34	3.31	5.06	3.54
Dec.	5.71	1.92	4.13	1.99	3.35	2.08	4.09	3.28	3.56	3.50
1958										
Jan.	5.87	1.86	4.22	1.93	3.41	2.02	4.22	3.18	3.77	3.40
Feb.	6.21	1.89	4.73	1.96	3.87	2.05	5.05	3.23	4.75	3.46
March	6.75	1.96	5.05	2.04	4.28	2.13	5.65	3.36	5.32	3.59
April	6.93	2.16	4.86	2.25	3.86	2.34	4.96	3.70	4.81	3.96
May	6.77	2.20	4.79	2.28	4.18	2.38	5.32	3.76	4.77	4.02
June	6.72	2.24	5.22	2.33	4.35	2.43	5.41	3.84	5.10	4.11
July	6.93	2.25	5.44	2.34	4.66	2.44	6.32	3.85	5.47	4.13
Aug.	6.71	2.27	5.07	2.37	4.48	2.47	6.51	3.90	5.68	4.17
Sept.	6.09	2.15	4.76	2.24	4.22	2.34	5.92	3.69	5.50	3.95
Oct.	5.37	1.98	4.10	2.06	3.72	2.15	5.22	3.39	5.14	3.63
Nov.	5.07	1.92	3.57	2.00	3.18	2.08	4.40	3.29	4.43	3.52
Dec.	......	2.00	3.50	2.08	3.08	2.17	3.21	3.43	3.53	3.67

puted for each month in 1955 and 1956, the data probably would show that it would be unprofitable to go beyond 270 pounds and, in some months, even unprofitable to go beyond 240 pounds. It appears that there is a positive correlation between high hog prices and increased optimal marketing weights. Marginal costs have been steadily declining since 1955, and this had some effect. The effect of the decreasing marginal cost, however, was less than the effect of the increasing marginal revenue in this case.

The following conclusions by Atkinson and Klein (1, p. 12) also apply to some of the results in table 15 obtained from this direct-payment study: The farmer must take his choice between marketing a 200-pound hog at a specific time or marketing the hog at 250 pounds a month later. He must consider price discounts and seasonal movements to determine the advantage of either weight in terms of profit. For the 13-year period, 1947-59, early spring pigs farrowed in February and March could be marketed more favorably at 200 pounds than at 260 pounds and above. Pigs farrowed in April, the peak spring farrowing month, have little or no discounts for heavier weights, whereas the May and June pigs actually bring higher prices at weights of 240 and 270 pounds than at 200 pounds.

For the period, 1930-41, July may be considered a transitional month. Pigs farrowed earlier could be kept to heavier weights and could be sold at higher prices, but the pigs farrowed in July, although they bring about the same price at 240 pounds as at 200 pounds, are discounted at heavier weights. For the period 1947-59, pigs farrowed later in July could be profitably carried to heavier weights (refer to table 15). For pigs farrowed in September, the peak fall farrowing month, the hogs carried beyond 240 pounds brought a higher price than those at 200 pounds. The September pigs, during the period 1947-59, could be carried profitably to heavier weights. "There is a premium on heavy marketing weights for October pigs which sell at higher prices each month up to 300 pounds; whereas, November pigs bring slightly higher prices at 250 pounds than at heavier weights" (1, pp. 12-14). For the period 1947-59, the November pigs farrowed earlier in the month could be carried profitably to 240 pounds, but for pigs farrowed later in the month, the 270-pound hogs had the profitability advantage over the 240-pound hogs.

"There is a discount on heavier weights of pigs farrowed in December, and, in the months following, this discount grows larger" (1, p. 14). Therefore, timeliness of farrowing is quite important in determining the profitable weight at which to market hogs.

The optimum marketing weights calculated for prior years in this and later sections are those at which any *individual* average producer could have maximized returns. If *all* producers had marketed at these optimum weights, then the price-supply relationship would have changed and, with it, the optimum marketing weights.

Estimated Cost of Direct Payments for Lightweight Hogs

What would a program cost to induce farmers to sell their hogs at lighter weights? This cost would depend, first, on the size of the payment necessary to induce farmers to market their hogs at lighter weights. This payment would have to be at least as large as the profits[9] that farmers would forego by selling their hogs at lighter weights; so the first step is to estimate what those profits are. Profit is equal to total revenue minus total cost, so it is necessary to determine both total revenue and total cost.

Estimates of profits based on weekly price data with one farrowing date

Since there is a considerable amount of variation in hog prices from year to year and even from week to week, marginal returns for hogs 180 to 300 pounds, using a 10-pound interval, are computed for a 10-year period, 1949 through 1958 (refer to table 17). Weekly Chicago market prices (32) of U.S. Number 1, 2 and 3 grade barrows and gilts are used to compute the total returns on hogs. April 15 is chosen as the farrowing date. On the basis of Atkinson and Klein's (1) work and also Beneke's (4) suggestion, a gain of 1.25 pounds per day is used for all weights from 180 to 300 pounds. It is possible then to determine at what time period hogs reach different weights. The hogs farrowed April 15 are assumed to weigh 180 pounds on Nov. 1, 200 pounds on Nov. 15, etc. Actual hog and feed prices are used for these specific time periods.

A risk factor (i.e., the risk of losses beyond 200 pounds) also is included in the computation of marginal revenues. According to Speer (30) the risk could be about $\frac{1}{2}$ of 1 percent for the weights that are considered. This was found to be insignificant; that is, it did not affect the results.

Results show that there is considerable variation in marginal returns from year to year; in several cases there actually are negative marginal returns. For example, for the weight group of 250-260 pounds, during

[9]As in the preceding section where yearly and monthly prices are used, this payment is the return over variable costs, but to be concise, it is referred to as "profit."

Table 17. Marginal revenues using weekly Chicago market prices and a 10-pound interval for years 1949-58 with the farrowing date on April 15 (in dollars).[a]

Year	Date: Weight	11/1 11/7 180- 190	11/7 11/15 190- 200	11/15 11/23 200- 210	11/23 12/1 210- 220	12/1 12/9 220- 230	12/9 12/17 230- 240	12/17 12/25 240- 250	12/25 1/3 250- 260	1/3 1/11 260- 270	1/11 1/19 270- 280	1/19 1/27 280- 290	1/27 2/5 290- 300
1949		0.74	0.55	1.64	0.83	1.17	0.45	1.95	1.29	—0.14	2.37	3.58	3.62
1950		1.08	0.81	1.56	1.79	2.14	4.63	4.41	2.40	0.80	2.29	2.79	6.33
1951		0.78	0.90	2.50	1.24	1.07	0.62	2.49	1.28	—0.25	1.57	1.90	1.58
1952		2.33	0.79	0.90	1.29	1.39	1.13	4.85	1.53	1.65	3.34	1.80	2.26
1953		2.07	2.80	5.21	4.65	2.86	2.76	4.38	1.51	4.14	3.32	4.13	1.81
1954		2.71	1.56	0.93	0.59	1.44	—1.65	2.59	0.54	0.26	1.80	1.47	0.95
1955		0.49	—0.33	—0.03	—0.05	0.52	—1.42	2.88	0.58	0.08	1.44	5.97	1.23
1956		2.01	0.83	2.96	2.17	5.11	0.62	2.72	1.44	0.89	4.53	1.84	—0.05
1957		—1.03	2.88	1.88	3.24	3.63	1.19	3.81	—1.23	1.35	4.63	0.74	2.64
1958		2.26	2.11	1.46	0.61	2.23	—0.13	2.50	—1.47	1.03	......	......	......

[a]Adjusted for a risk factor of $\frac{1}{2}$ of 1 percent.

Year	Date:	11/1 11/7	11/7 11/15	11/15 11/23	11/23 12/1	12/1 12/9	12/9 12/17	12/17 12/25	12/25 1/3	1/3 1/11	1/11 1/19	1/19 1/27	1/27 2/5
	Weight:	180- 190	190- 200	200- 210	210- 220	220- 230	230- 240	240- 250	250- 260	260- 270	270- 280	280- 290	290- 300
1949		1.44	1.44	1.51	1.58	1.60	1.66	1.67	1.70	1.79	1.80	1.88	1.90
1950		1.42	1.42	1.49	1.54	1.56	1.62	1.63	1.63	1.72	1.72	1.80	1.76
1951		1.56	1.56	1.64	1.68	1.70	1.76	1.77	1.75	1.85	1.86	1.94	1.90
1952		1.37	1.37	1.43	1.49	1.51	1.57	1.58	1.57	1.64	1.66	1.74	1.73
1953		1.31	1.31	1.38	1.41	1.43	1.49	1.50	1.50	1.58	1.59	1.67	1.67
1954		1.21	1.22	1.27	1.32	1.34	1.38	1.39	1.39	1.45	1.46	1.57	1.55
1955		0.97	0.98	1.03	1.06	1.07	1.11	1.12	1.14	1.19	1.21	1.27	1.28
1956		1.04	1.05	1.10	1.10	1.12	1.17	1.18	1.29	1.34	1.37	1.42	1.38
1957		1.00	1.02	1.07	1.06	1.07	1.10	1.11	1.12	1.16	1.18	1.23	1.25
1958		1.01	1.01	1.06	1.11	1.12	1.17	1.19	1.18	1.23	1.26	1.30	1.31

[a]Marginal costs include feed costs and interest on investment.

the period Dec. 25, 1958, to Jan. 3, 1959, the marginal return is —$1.47 (refer to table 17).

Monthly prices are used to compute marginal costs (31, 34). For purposes of this study, fixed costs such as depreciation and interest on equipment and shelter need not be considered. These costs have already been incurred and, thus, would not determine at what weights the hogs should be marketed. At the suggestion of Beneke (4), interest on investment is included in marginal cost. An interest rate of 5 percent per annum is used. The interest on investment (to be added to marginal cost) for 1949-58, using an April 15 farrowing date, ranges from $0.03 for the lightweight hogs to $0.07 for the heavy. Marginal costs, including interest on investment, for 1949-58, using an April 15 farrowing date, are shown in table 18.

The marginal costs are computed on a monthly basis since the variations in feed prices are negligible from week to week. The data in fig. 12 show that there is l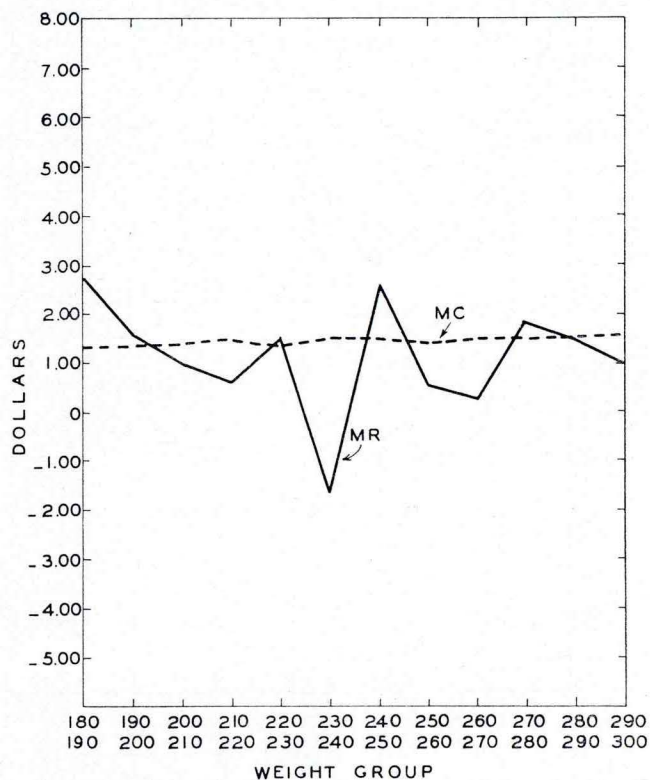ittle varation in marginal costs from time to time; the line representing marginal costs appears to be either straight or gently sloped.

The weekly data show several intersections of marginal revenue and marginal cost. The reason is that the hog prices vary a great deal from week to week. For example, if one looks at fig. 12 for 1954, when a 10-pound interval is used, the April 15 farrowing date shows intersections between the weight groups of 190-200 and 200-210, between 210-220 and 220-230, etc. There are six intersections altogether. Each intersection of the marginal revenue and marginal cost lines represents one optimal marketing weight.

Profits (incentive payments) are computed from 200 pounds liveweight upward. Since there are usually several profitable weights above 200 pounds at which farmers could market their hogs, the marketing weight for which the farmer receives the *greatest* amount of profit is the one chosen for calculation of the incentive payments. The incentive payments must at least be equal to the profit made beyond 200 pounds to induce farmers to market their hogs at lighter weights. Using the April 15 farrowing date, the incentive payments that are needed are presented in table 19. The size of these payments varies from no payment for 1954 and 1955 to $19.55 per hog in 1953.

Estimates of profits based on weekly price data with 12 farrowing dates

Beneke (4) suggested that, to determine the total cost of the program with acceptable precision, it would be advisable to choose at least 12 farrowing dates. These are chosen to be on the 15th day of each month of the year for a 4-year period, beginning at Jan. 15, 1955, and ending at Dec. 15, 1958.

In determining profits and incentive payments, the hogs farrowed Jan. 15 are assumed to weigh about 180 pounds each on Aug. 1; they are assumed to weigh about 200 pounds each on Aug. 15 and 220 pounds each near

Fig. 12. Marginal revenues and marginal costs using a farrowing date of April 15 and a 10-pound interval, 1954 data.

Table 19. Incentive payments per hog computed on a weekly basis with a 10-pound interval and an April 15 farrowing date, for years 1950-58 (in dollars).[a,b]

Year	Payment per hog
1950	12.67
1951	0.86
1952	4.22
1953	19.55
1954	0
1955	0
1956	11.19
1957	10.53
1958	1.02

[a]Incentive payments = Σ marginal revenue — Σ marginal costs from 200 pounds to the optimal marketing weight for which the farmer receives the **greatest** amount of profit.
[b]Payments for marketing at 200 pounds or below.

the end of August. The total values of the hogs are computed from 200 pounds upward to 300 pounds, and marginal revenues are computed from these. Three different types of hog prices are used: (a) actual prices, (b) a fixed price and (c) moving-average prices. The marginal costs are computed on a monthly basis, and the optimal marketing weights are again determined.[10]

The incentive payments are equal to the sum of the marginal revenues for each 10-pound interval minus the sum of the marginal costs for each 10-pound interval from 200 pounds up to the optimal marketing weight. Again, there are usually several profitable marketing weights above 200 pounds, and the weight for which the farmer receives the *greatest* amount of profit is the one chosen for calculation of the incentive payments. These are the payments which appear in figs. 13 through 15. The incentive payments for the hogs farrowed Jan. 15 appear on Aug. 15, while the incentive payments for hogs farrowed Feb. 15 appear on Sept. 15, etc. The reason the payments appear this way is that the farmer receives his payment at the time the hogs reach 200 pounds rather than at farrowing time. As a result, there are no incentive payments for the first 7 months of 1955 or the last 5 months of 1959. Figures 13 through 15 show the relative size of the incentive payments in different years.

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[10]The marginal costs, total values, marginal revenues and incentive payments, using all three types of hog prices, are available from the senior author.
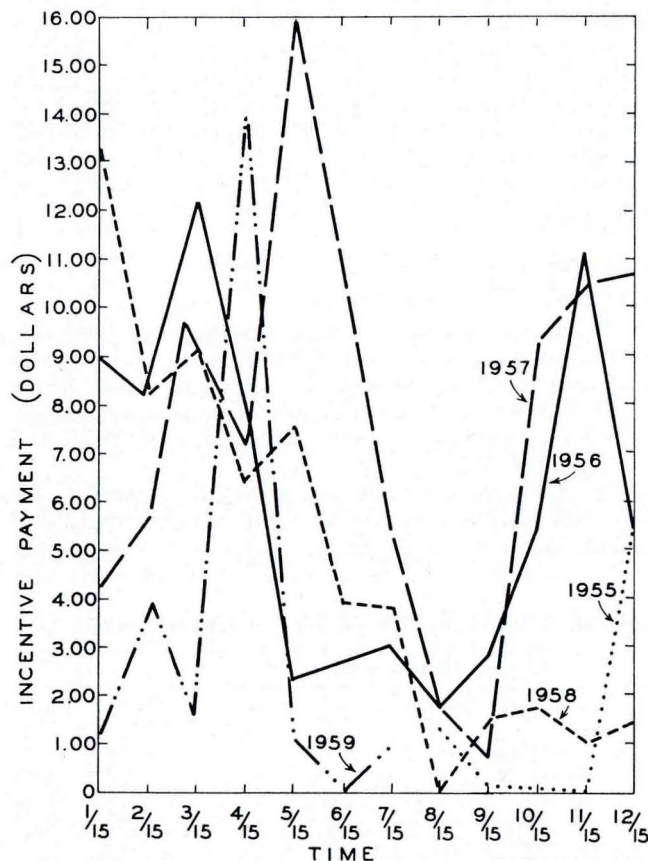
These payments also are used to compute the total cost of the program to the government.

When actual weekly Chicago prices (32) for U.S. Number 1, 2 and 3 grade barrows and gilts are used, the incentive payments per hog range from $0 to $15.84. However, the payments are not consistent; in other words, the payment in a particular month may be high one year and very low for the same month the next year. This is illustrated in fig. 13 where, for the month of May, the incentive payment in 1957 is $15.84, but, for the same month in 1956, it is only $2.27. The cyclic fluctuation may have caused the inconsistency of the size of incentive payments from year to year. The seasonal fluctuation, too, has an effect on size of payments, but this may well be overshadowed by the cyclic fluctuation. The general variation with actual prices is as follows: The size of payment is fairly high in January, it rises in the following months and reaches its peak in March, April or May. Then it declines, reaching the low point usually in August or September.

In addition to using actual prices, a fixed price also is used to determine incentive payments and cost of the program. This price is derived by averaging weighted average Chicago prices of U.S. Number 1, 2 and 3 grade barrows and gilts (35, 36) over the 5-year period, 1955-59. When the fixed price of $16.18 per hundredweight is used, there are usually one or two optimal marketing weights, rather than three or four as is true when the actual prices are used. The optimal (maximum profit)

Fig. 13. Incentive payments using actual prices with a 10-pound interval; payments for marketing at 200 pounds or below for years 1955-59.
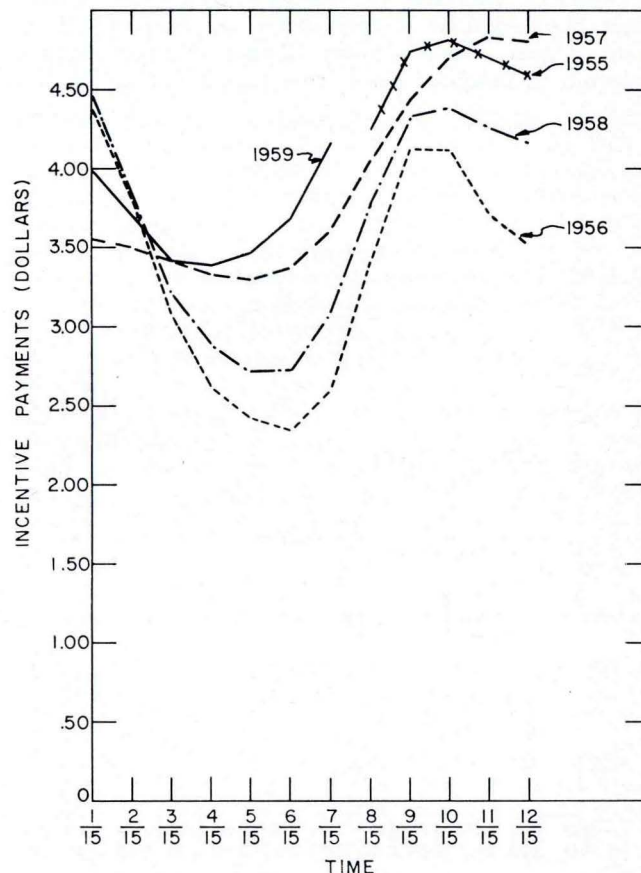

Fig. 14. Incentive payments using a fixed price of $16.18 per hundredweight with a 10-pound interval; payments for marketing at 200 pounds or below for years 1955-59.

marketing weight under these conditions is usually 280 or 300 pounds, and the incentive payments range from $2.35 to $4.83. The payments are above $2.50 for most periods (see fig. 14). The variation in the size of incentive payments is relatively small when compared with the variation in the size of incentive payments when either actual prices or moving-average prices are used.

In 1957, the payment is $3.56 on Jan. 15; it declines to a low of $3.30 on May 15 and rises to its highest point of $4.83 on Nov. 15. The variation in the size of the incentive payments is caused by a movement in feed costs (31). The other years, especially 1956 and 1958, had more variation in the size of incentive payments. For example, the 1956 payments vary from $4.83 on Jan. 15 to $2.35 on June 15, while the 1958 payments vary from $4.46 on Jan. 15 to $2.71 on May 15. Even though there is a similarity in the variation in the size of the incentive payments, there is a difference in the time the payments reach their peaks. In 1955, the peak in the size of the incentive payments is attained on Oct. 15; in 1956, it is reached on Jan. 15; in 1957, it is reached on Nov. 15; and in 1958, it is reached on Jan. 15.

The moving-average prices are derived by averaging Chicago prices for U.S. Number 1, 2 and 3 grade barrows and gilts by weeks over the 5-year period, 1955-59 (32). These prices are presented in table 20. The same 5-year period is used to determine the moving-average prices by weeks as is used to determine the fixed price of $16.18. Therefore, it is possible to compare the size of the incentive payments and total costs of the program derived by use of the moving-average prices with those derived by use of the fixed price and actual prices. In addition, moving-average prices are used to reduce the effects of cyclic fluctuations and any other economic occurrences such as a war or a threat of war.

With moving-average prices, instead of having many sharp fluctuations in hog prices which could cause unusual profits in some periods, there is a smoothing-out effect; thus, profits maintain normality. Because the effects of cyclic fluctuation are reduced with moving-average prices, the variation in the size of incentive payments also is reduced. The incentive payments using moving-average prices range from $0.95 to $9.32 (see fig. 15).

There is more consistency in the size of the payments when moving-average prices are used. The general pattern shows that the incentive payments are fairly high early in the year, about $6, then increase even more and reach a peak of about $9 on April 15 of each year. Following this, there is a general decline, reaching a low of about $1 on Sept. 15, and then an increase to Nov. 15

Table 20. Moving-average hog prices, 1955-59 (in dollars).[a]

Dates	180-200	200-220	220-240	240-270	270-300
12/31-1/7	16.98	16.92	16.65	15.93	15.41
1/7-1/14	17.00	16.95	16.65	15.94	15.27
1/14-1/22	17.08	16.97	16.67	16.14	15.55
1/22-1/29	17.38	17.33	17.14	16.47	15.86
1/29-2/2	17.23	17.30	17.15	16.54	16.11
2/2-2/9	17.21	17.26	17.10	16.51	16.20
2/9-2/15	16.86	16.99	16.85	16.35	16.03
2/15-2/23	16.54	16.70	16.61	16.16	15.98
2/23-3/2	16.14	16.36	16.29	15.92	15.83
3/2-3/9	16.21	16.45	16.38	16.10	15.89
3/9-3/16	16.39	16.61	16.57	16.27	16.05
3/16-3/30	16.89	17.12	17.09	16.82	16.66
3/30-4/6	17.48	17.70	17.66	17.44	17.34
4/6-4/13	17.73	17.83	17.73	17.45	17.47
4/13-4/20	17.69	17.97	17.87	17.53	17.51
4/20-4/27	17.66	17.89	17.79	17.43	17.31
4/27-5/4	17.49	17.72	17.59	17.21	17.02
5/4-5/11	17.59	17.89	17.63	17.17	17.03
5/11-5/18	17.93	18.11	17.91	17.52	17.29
5/18-5/25	18.36	18.56	18.35	17.84	17.82
5/25-6/1	18.94	19.13	18.90	18.34	18.30
6/1-6/8	19.28	19.41	19.27	18.78	18.72
6/8-6/15	19.21	19.40	19.18	18.56	18.10
6/15-6/22	19.31	19.50	19.28	18.64	18.74
6/22-6/29	19.70	19.87	19.69	19.15	19.20
6/29-7/6	19.47	19.71	19.63	19.04	19.19
7/6-7/13	19.22	19.67	19.55	20.00	19.35
7/13-7/20	19.04	19.56	19.30	19.84	19.31
7/20-7/27	18.56	18.91	18.81	19.62	19.17
7/27-8/3	18.41	18.80	18.78	19.74	19.28
8/3-8/10	18.25	18.73	18.80	19.68	19.25
8/10-8/17	17.94	18.44	18.48	19.33	18.96
8/17-8/24	17.82	18.20	18.32	19.16	18.81
8/24-8/31	17.81	18.16	18.26	19.02	18.72
8/31-9/7	17.51	17.87	17.99	18.80	18.59
9/7-9/14	17.15	17.56	17.66	18.51	17.56
9/14-9/21	16.55	17.31	17.37	18.14	17.63
9/21-9/28	16.69	16.97	17.06	18.13	17.57
9/28-10/5	16.92	17.19	17.22	18.01	17.69
10/5-10/12	16.47	16.72	16.77	17.55	17.20
10/12-10/19	16.20	16.38	16.39	17.16	17.02
10/19-10/26	15.90	16.13	16.13	16.75	16.53
10/26-11/2	15.89	16.03	15.99	16.48	16.24
11/2-11/9	15.61	15.69	15.63	16.06	15.68
11/9-11/16	15.57	15.64	15.56	15.85	15.28
11/16-11/23	15.62	15.65	15.50	15.79	15.55
11/23-11/30	15.28	15.28	15.09	15.28	15.02
11/30-12/7	15.46	15.52	15.27	15.35	14.99
12/7-12/14	15.48	15.54	15.31	14.74	15.02
12/14-12/21	15.74	15.74	15.47	14.84	15.07
12/21-12/28	16.03	16.01	15.70	15.04	15.41
12/28-1/2	15.11	15.12	14.83	14.07	14.49

[a]The moving average prices are derived by averaging Chicago prices for U. S. No. 1, 2 and 3 barrows and gilts by weeks over the 5-year period, 1955-59. Data from U. S. Department of Agriculture (32).
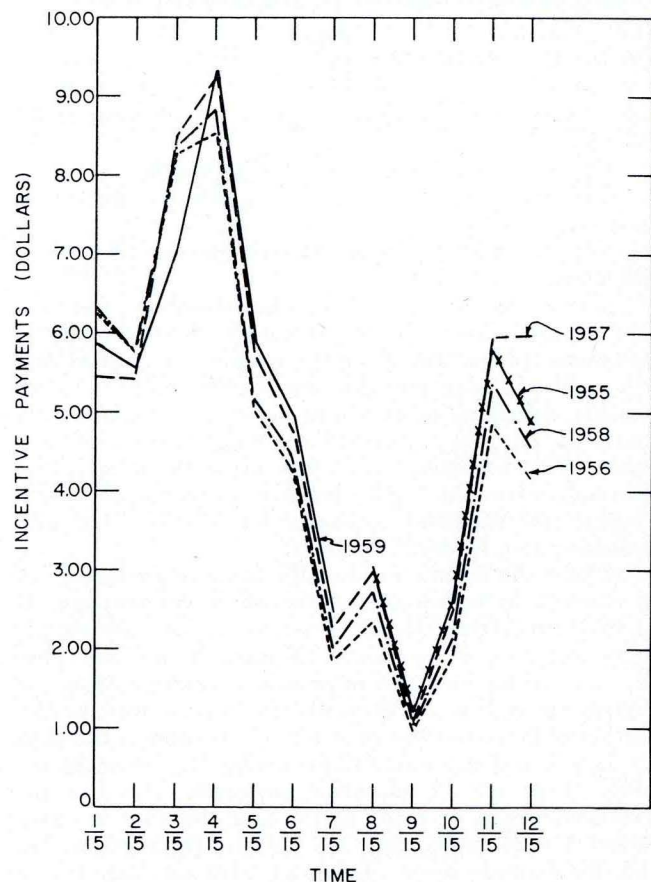

Fig. 15. Incentive payments using moving-average prices with a 10-pound interval; payments for marketing at 200 pounds or below for years 1955-59.

and another decline at the end of the year. This variation is caused primarily by seasonal fluctuation in hog prices.

Estimates of total cost of the program

The cost of a direct-payment program restricted to lightweight hogs would depend mostly on two things: (a) the percentage of barrows and gilts desired to be marketed at 200 or 220 pounds and less and (b) the precise effect that the increase in lightweight hogs would have on the price differentials between weight groups. With no past market situations involving a very large percentage of lightweight hogs, it is virtually impossible to estimate accurately what would happen to the price differentials.

We can, however, estimate the initial cost of the program for commercial barrow and gilt slaughter, including plants with and without federal inspection. The additional cost resulting from an increase in the amount of lighter hogs marketed after payments begin is not included. We can only estimate the first cost, assuming direct payments with no effect on the weight at which hogs are sold.

To determine the costs of the program, weekly federally inspected hog-slaughter data (35, 36) are adjusted to derive weekly commerical hog-slaughter estimates (commercial hog-slaughter data are not available by weeks). To derive these estimates, it is necessary to adjust weekly federally inspected hog slaughter as follows:

$$CS_{ij} = \frac{CS_j}{FIS_j} \cdot FIS_{ij}$$

where CS_{ij} = commercial slaughter for ith week of jth month,

CS_j = commercial slaughter for jth month,

FIS_j = federally inspected slaughter for jth month, and

FIS_{ij} = federally inspected slaughter for ith week of jth month.

These weekly commercial hog-slaughter estimates are adjusted down by the percentage of sows marketed by weeks (32). This gives the weekly commercial *barrow and gilt* slaughter for the United States. Chicago market estimates indicate that about 15 percent of the barrows and gilts marketed there weigh 200 pounds and under. This percentage is used to adjust the weekly commercial barrow and gilt slaughter estimates to weekly commercial slaughter estimates for barrows and gilts weighing at or below 200 pounds.

Under the assumption that the farmers producing 100 percent of the hogs would participate in the program, the weekly commercial slaughter estimates for barrows and gilts weighing at or below 200 pounds are multiplied by the various incentive payments to obtain a total cost figure. Costs also are estimated for an assumed participation of those farmers producing 70 percent of the hogs.

In a preceding section, 12 farrowing dates were chosen; thus, there are 12 incentive payments. The incentive payment would be made at the time the hogs are marketed. For example, when the pigs are farrowed on Jan. 15, the farmers could receive payment on Aug. 15, because the hogs would weigh approximately 200 pounds at this time. It is assumed that this incentive payment could be used throughout the entire month of August. In other words, there is one incentive payment for all of the January farrowings, all of the February farrowings, etc. These payments are determined in an earlier section for each month of the year and for a 4-year period, beginning with the first farrowing date, Jan. 15, 1955, and ending with the last farrowing date, Dec. 15, 1958.

When a fixed price of $16.18 per hundredweight is used, the payments and the total costs to the government are moderate (see fig. 14 and table 21). The cost of the program, assuming 100 percent participation, is lowest in 1958, with a total cost of $233,213,092. The 1957 figure is highest, with a cost of $251,560,776.

Why are certain years high, while others are low? The incentive payments for 1955 averaged $4.62 per hog. This is the highest average figure for any year considered; thus, it partially explains why the year 1955 (includes only 5 months) had such a high total cost. The average incentive payment for 1956 is lowest, with a figure of $3.35 per hog.

Another question might be, why does the size of payments vary? Since the price of hogs is fixed at $16.18 per hundredweight, the variation in the size of payments must be due to the variation in feed costs. In 1955, the average corn price was only $1.24 per bushel for the last 5 months; this is the lowest corn price for the period, except for 1958. Meat scraps and soybean meal prices were comparatively high in 1955, but the fact that corn made up the major part of the ration explains why the incentive payments are so high. In 1956, the soybean meal price was $4.01 per hundredweight, the meat scraps price was $4.73 per 100 pounds and the corn price was $1.42 per bushel (31). This represented the highest corn price, thus, lowering profits and also lowering the incentive payments. Soybean meal and meat scraps were comparatively low in price in 1956, but the incentive payments are lowest because of the high average corn price. The higher incentive payment in 1957 can be explained by a decline in corn price from $1.42 per bushel in 1956 to $1.27 per bushel in 1957. Moreover, there was a decline in the price of meat scraps from $4.73 per 100 pounds in 1956 to $4.71 per 100 pounds in 1957 and a decline in the price of soybean meal from $4.01 in 1956 to $3.80 in 1957. The incentive payments in 1958 and 1959 are fairly low, but not as low as those in 1956 — a difference that can be explained by the fact that the average prices of meat scraps were highest in 1958 and soybean meal prices also were comparatively high. Meat scraps increased most from $4.71 per 100 pounds in 1957 to $5.80 in 1958, while soybean meal moved from $3.80 per 100 pounds in 1957 to $4.14 in 1958. The corn price was lowest this particular year; however, the very high

Table 21. Total cost to the government of incentive-payment program using a fixed price of $16.18 per hundredweight, a 10-pound interval, and 70- and 100-percent participation for years 1955-59 (in dollars).[a]

Year	Total cost	
	100% participation	70% participation
1955[b]	142,719,537	99,453,687
1956	239,521,102	167,664,788
1957	251,560,776	176,086,231
1958	233,213,092	163,249,198
1959[c]	150,208,397	105,145,870
Total	1,017,222,904	711,599,774

[a]Total cost computed by multiplying incentive payments by adjusted commercial barrow and gilt slaughter.
[b]Includes only 5 months.
[c]Includes only 7 months.

Table 22. Total cost to the government of incentive-payment program using actual prices, 10-pound interval, and 70- and 100-percent participation for years 1955-59 (in dollars).[a]

Year	Total cost	
	100% participation	70% participation
1955[b]	36,586,573	25,610,602
1956	462,660,908	323,862,675
1957	483,700,435	338,590,370
1958	314,877,176	220,411,064
1959[c]	131,505,533	92,010,381
Total	1,429,330,625	1,000,485,092

[a]Total cost computed by multiplying incentive payments by adjusted commercial barrow and gilt slaughter.
[b]Includes only 5 months.
[c]Includes only 7 months.

soybean meal and meat scraps prices more than offset the lower corn price.

There is an additional factor which determines the total cost — the number of hogs slaughtered in these years. The number of hogs slaughtered in 1955, especially during the last few months, was much higher than in later years. This caused the price of hogs to drop drastically in the last month or two of 1955. Commercial slaughter of barrows and gilts for the week ending Dec. 10, 1955, was 2,027,162; for comparable weeks, it was 1,622,741 in 1956; 1,461,667 in 1957; 1,468,763 in 1958; and 1,764,429 in 1959. In the first 2 or 3 months of 1956, slaughter figures were higher than in the other years. For example, commercial slaughter of barrows and gilts for the week ending Jan. 8, 1955, was 1,555,642; for comparable weeks it was 1,597,895 in 1956; 1,276,682 in 1957; 1,159,677 in 1958; and 1,164,389 in 1959. Similar relationships hold true for about the first 2 months, although 1959 slaughter surpassed 1955 slaughter in some weeks.

When actual prices are used to determine the total cost of the program, the government payments are much higher (refer to table 22). Even though the 1956 prices were low earlier in the year, they increased gradually throughout the remainder of the year. This partially explains why the 1956 cost is comparatively high when actual prices are used. The prices had recovered fairly well by April 1956. However, the 1958 prices were even higher than the 1956 and 1957 prices, although the 1957 prices were fairly high, too. Another reason for the comparatively high cost in 1956 is that, on the average, commercial barrow and gilt slaughter was greater in 1956 than in 1957 or 1958. One reason the cost of the program is highest in 1957 is that feed prices declined that year, thus, increasing profits.

In 1958, corn prices were lowest, declining from $1.27 per bushel in 1957 to $1.23 per bushel in 1958, while the soybean meal prices were comparatively high, and meat scraps prices were highest. The considerable increase in meat scraps and soybean meal prices could have more than offset the lower corn price and, thus, helps to explain why the 1958 total cost is not so high. In addition, commercial barrow and gilt slaughter was lowest in 1958.

Table 23. Total cost to government of incentive-payment program using a moving-average price, 10-pound interval, and 70- and 100-percent participation for years 1955-59 (in dollars).[a]

Year	Total cost	
	100% participation	70% participation
1955[b]	114,766,353	80,336,453
1956	328,663,820	230,064,687
1957	323,529,436	226,472,982
1958	304,967,407	213,767,197
1959[c]	244,341,271	171,038,879
Total	1,316,268,287	921,680,198

[a]Total cost computed by multiplying incentive payments by adjusted commercial barrow and gilt slaughter.
[b]Includes only 5 months.
[c]Includes only 7 months.

Moving-average prices could be of more value to the farmer as far as projecting what will happen than either actual prices or a fixed price. These prices are averaged week by week and, therefore, have a tendency to smooth out the price fluctuations throughout the year. The total costs when moving-average prices are used appear in table 23. In 1956, the cost is higher than in 1957 or 1958, reflecting the fact that commercial barrow and gilt slaughter was higher in 1956 than it had been since 1952. The 1958 cost again, as when actual prices are used, is comparatively lower, because the prices of meat scraps and soybean meal made a recovery that year, although corn prices declined slightly. This means that, with moving-average prices, the profit is less during this year; therefore, the incentive payments have to be less too.

Figure 16 shows the relationship between costs to the government when a fixed price of $16.18 per hundredweight is used, when actual prices are used and when moving-average prices are used. In fig. 16, it can be seen that, when actual prices are used, the fluctuation in total cost from year to year is much greater than when the moving-average price or fixed price is used.

Since the assumption that the farmers producing 100 percent of the hogs will participate in the program is unrealistic, it is necessary to choose some percentage to represent the number of hogs that might realistically be committed to such a program. Beneke (4) suggested that 70 percent would be a fair estimate.

The cost for a full 4-year period, which includes 5 months in 1955 and 7 months in 1959, is $711,599,774 for 70-percent participation when the $16.18 per hundredweight price is used. The cost for 100-percent participa-
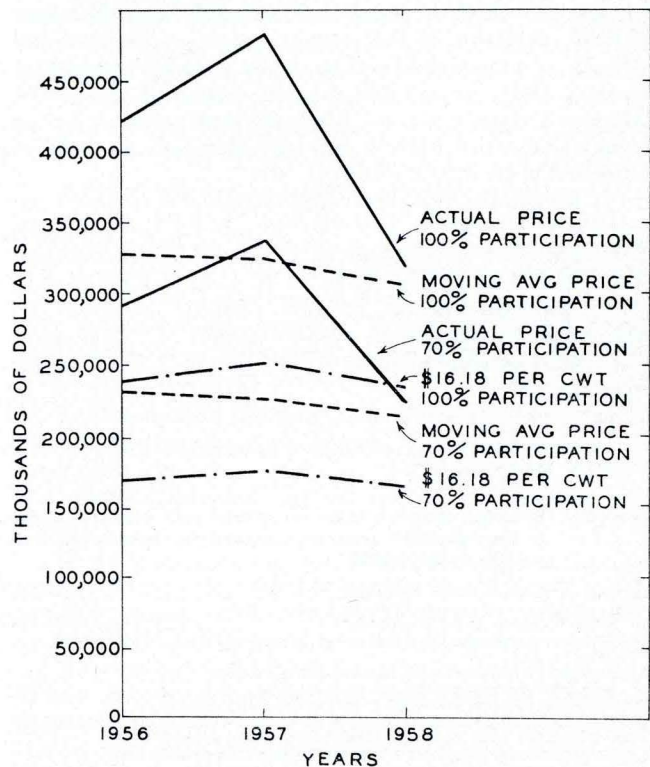

Fig. 16. Total cost to the government using a fixed price of $16.18, actual prices and moving-average prices with a 10-pound interval and 70- and 100-percent participation for years 1956-58.

tion is $1,017,222,904 (refer to table 21). The cost for the full 4-year period, when actual prices are used with 100-percent participation is $1,429,330,625, while it is $1,000,485,092 for 70-percent participation (refer to table 22). When moving-average prices are used, the costs are $1,316,268,287 with 100-percent participation and $921,-680,198 with 70-percent participation (refer to table 23).

The cost of the program when actual prices are used is extremely high, especially when 100-percent participation is assumed. Even with 70-percent participation, the cost is over $1 billion for the 4-year period, a cost to the government of more than $250 million per year.

Effects of the Program

The question now remains: What would be the effects of such a program were it put into operation? The program effects in the long run would be different from those in the short run.

Short-run effects

In the short run,[11] the program could reduce pork production substantially, and from a farmers' standpoint, it could also remove some of the uncertainty connected with hog production. Table 24 shows an estimate of the reduction in total pork production that could have been possible under such a program in 1959.

Commercial hog slaughter in the United States in 1959 was 81,581,900 head, and federally inspected hog slaughter makes up about 85 percent of commercial hog slaughter (36). Approximately 90 percent of 1959 federally inspected hogs slaughtered was barrows and gilts (36). Commercial barrow and gilt slaughter in 1959, therefore, is estimated by multiplying 81,581,900 times 90 percent, which is equal to 73,423,800 head. The best estimate available of the average weight of barrows and gilts in commercial slaughter is the average weight of barrows and gilts at eight markets combined. For 1959, this was 228 pounds (36). Thus, the total pounds of pork from commercial barrow and gilt slaughter in 1959 is estimated at 16,740,605,880.

If we assume that the average weight could have been reduced from 228 to, say 220 pounds by the program, then total pork production in 1959 could have declined from 16,740,605,880 pounds to 16,153,216,200 pounds, for a reduction of 587,389,680 pounds, or about 3.5 percent. If we assume an average weight of 228 pounds, this would be equivalent to a reduction of 2,576,270 barrows and gilts.

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[11] As used here, short run is defined as immediate effects within a production period.

Table 24. Estimated short-run reduction in total pork produced under a direct-payment program designed for lightweight barrows and gilts in 1959.[a]

Total hogs in commercial slaughter	81,581,900
Approximate percentage barrows and gilts of total hogs in commercial slaughter	90
Total barrows and gilts in commercial slaughter (row 1 times row 2)	73,423,710
Approximate average weight in pounds of barrows and gilts in commercial slaughter	228
Total pounds of pork produced from barrows and gilts in commercial slaughter (row 3 times row 4)	16,740,605,880
Total pounds of pork produced from barrows and gilts in commercial slaughter if average weight is reduced to 220 pounds by the program (row 3 times 220)	16,153,216,200
Reduction in total pounds of pork (row 5 minus row 6)	587,389,680
Reduction in total barrows and gilts in commercial slaughter (row 7 divided by 228)	2,576,270

[a] Basic data from U. S. Department of Agriculture (36).

Long-run effects

Under the program, the supply of lighter hogs would increase relative to the supply of heavier hogs; therefore, the price differential between lighter and heavier hogs would become smaller. This would offset part of the direct payments so that a new equilibrium between the prices of light and heavy hogs and the direct payment would be established, unless the incentive payments were made larger and larger year after year.

The seasonal pattern of prices probably would change because the average weight of hogs marketed would be lighter, and these lighter hogs could arrive at the market sooner. In other words, whereas highest prices now occur during August and September, they might be highest during June and July under the program. Instead of price breaking in October as it does now, it might break in September. Lowest prices might occur in October and November rather than in November and December.

If the incentive-payments program increased hog producers' incomes in the short run, it could induce farmers to produce a greater number of hogs. This increase in numbers could partly offset, or more than offset, the effects of the lighter average weight.

Table 24 indicates a reduction in 1959 pork production of about 3.5 percent. This would increase hog prices about 8.75 percent. (This is calculated by using a price elasticity of demand of −0.4 (29)[12] and multiplying 3.5 times $1/0.4 = 8.75$.) Where the elasticity of supply is less than the elasticity of demand, the cycle is converging and soon disappears. Where the elasticity of supply is greater than the elasticity of demand, the cycle is explosive and continues to grow. Empirical analysis (27, pp. 32-41) indicates that the elasticity of supply for hogs is about one until prices rise to about 30 percent above normal, and then it decreases to almost zero. At the point where elasticity of supply equals the elasticity of demand, the cycle would become self-perpetuating.

Accordingly, we use the elasticity of supply of 0.4, which is equal to the elasticity of demand. In response to the 8.75-percent increase in price, production would rise by 3.5 percent. (This is calculated by multiplying 8.75 times 0.4 = 3.5.) This would result in a decrease in price of 8.75 percent. This would bring the price back down to its original level.

Eventually, a new equilibrium of total supplies and prices would be established. Incomes presumably would remain about the same as before, since no change would have taken place in the over-all competitive conditions which determine incomes.

The new equilibrium would be attained with hogs at lighter weights but in larger numbers than before. Would this be in line with long-run consumer demands?

If consumers demand pork from lighter weight hogs, does the open market transmit those demands to producers now? Price differentials by weights now presumably reflect consumers' demands, yet the tables and charts on costs and returns in this bulletin indicate that an individual farmer would make more profit in most months of the year by carrying hogs to *heavier* weights than he

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[12] A more recent and comprehensive report (G. E. Brandow, Interrelations among demands for farm products and implications for control of market supply. Penn. Agr. Exp. Sta. Bul. 680. p. 59. August 1961) puts the elasticity at −0.4578. However, the authors considered the round figure of −0.4 sufficient for the purposes of this study.

does now. Is this a case where the short-run benefits to the individual producer (from carrying hogs to heavier weights) reduce profits for all producers as a group (because hogs are carried to heavier weights than consumers prefer)? Or is the present open market a reliable guide to increased profits for all hog producers? These questions require further research, along the lines indicated in a later section.

Limitations of Investigation

In any work of this nature, there are factors present which limit its scope and use. In the analysis of the program restricting payments to lightweight hogs, one of the assumptions made was that the daily gain was fixed at 1.25 pounds per day from 200 pounds upward to 300 pounds. However, other studies have indicated that the daily gain is highest at weights of 180-240 pounds. The gain thereafter declines as the hog becomes heavier. Thus, to more accurately determine the return over variable costs of carrying hogs beyond 200 pounds, it would be necessary to vary the rate of gain from one weight to another.

Limitations associated with determining the most profitable marketing weight

The data for feed consumed per 100 pounds were taken from Atkinson and Klein (1). Although these data are more than 15 years old, the assumption was made that the amount of feed consumed per 100 pounds gain still is representative of the average consumed by hogs in the Corn Belt and elsewhere. The reason for believing that this could be a valid assumption is that experimental pigs, at the time the trial was being conducted, had an advantage over farm-fed pigs. These experiments were conducted by experts who had college facilities at their disposal.

Menze (25) listed the following advantages that experimental pigs have over farm-fed pigs:

(a) The experimental pigs probably are fed a better balanced ration than are the average pigs on farms.

(b) The disease problem is cut down on the experimental pigs because of scientific handling and, in most cases, more sanitary conditions.

(c) It is quite probable that the pigs used in the experiment are of a more superior quality than average farm pigs.

Even though we assumed that a perfect growth chart could be drawn, with specified rate of gain and amount of feed required for every period in the life of a typical pig of a specified breed and type, we could not confidently tell the farmer the exact time to market his hogs because:

(a) It would be impossible to determine a precise marginal cost.

(b) A number of uncertainty factors would tend to confuse the application of a marginal cost and marginal revenue analysis. Some of the uncertainties involved would be price and cost expectations, uncertainties of disease, weather conditions and ability to predict precise behavior of all hogs.

(c) Other than marginal cost and marginal revenue, outside influences such as feed on hand and habit may determine time of marketing.

Limitations associated with the determination of incentive payments

Incentive payments were derived for hogs marketed during each month from August 1955 through July 1959. It was found that each month's incentive payment was different from year to year. Because of this variation, it is difficult to determine incentive payments in advance; e.g., setting the level of the 1963 incentive payments in 1961. It is not known whether these payments would be high enough to induce farmers to market at 200 pounds or whether they would be too high. The size of incentive payments needed will depend on the prices of the barrows and gilts at different weights, prices of feed and the amount of feed required to bring the hogs to various marketing weights. Another problem is that each individual farmer will be in a different situation. For one farmer the incentive payment may be approximately equal to the profit he believes he can make by carrying his hogs to a heavier weight. Another farmer may find that the incentive payment is too low and so will carry his barrows and gilts to a heavier weight. Still another farmer may find that the incentive payment is higher than the profit he could make by carrying his hogs to a heavier weight.

Limitations connected with determination of total cost

The primary purpose of the incentive-payment program is to reduce the total tonnage of pork coming to market by inducing farmers to market their hogs at lighter weights. The limitations associated with the determination of the size of incentive payments are: (a) The 4-year moving average might not fit next year's price movement and the farmers' anticipated profits close enough to make the program effective; and (b) individual differences between producers in efficiency of production and resulting profit, as well as individual differences between hogs in feed conversion and disease resistance, could not be taken into account.

Some of the administrative problems associated with this special kind of direct-payment program are: (a) At what maximum weight will hog be subsidized (190, 200, 210 pounds, etc.)? (b) What will be done about a situation where the farmer markets his hogs a pound or two over the maximum marketing weight; will he be penalized, receive a full payment, or no payment at all? (c) When should the incentive payments be announced?

In determining the total cost of the program, two of the things that must be known, and which cannot be predicted accurately, are: (a) the number of barrows and gilts eligible and (b) the size of the incentive payments.

There is an additional problem in predicting the total cost of the program. That is the fact that it is not known to what extent producers would increase production; i.e., total number of hogs raised. One reason for increasing production would be that the producer might have a certain amount of feed on hand; and where he previously used up this feed by carrying the barrows and gilts to heavier weights, the farmer might market them at a lighter weight to take advantage of the incentive-payment program. Another reason for increasing production is that the producer might want to have more barrows and

gilts on which to receive payment. It is likely that, in a few years, the increase in the number of barrows and gilts would offset, or more than offset, the reduction of pork marketed because of the lighter average weight of hogs.

If the number of barrows and gilts increased, payments would probably increase, and, thus, the cost of the program would increase. Another factor that would increase the cost is that the price differential between lighter and heavier weights would become narrower because of the incentive-payment program. That is, the price per pound of the lighter hogs would no longer be much higher than the heavier weight hogs throughout most of the year. This narrowing of the price differential would increase the size of the payment needed to induce farmers to market their hogs at lighter weights because the anticipated profits of carrying the hogs to heavier weights would increase.

SUGGESTIONS FOR FURTHER STUDY

It would seem that research could profitably be devoted to an examination of variations or combinations of the programs that were considered in the study. For example, a quota program could be used in combination with a program that would limit payments to 100 or 200 hogs per producer. This type of program could remove the incentive for small-scale producers to expand production up to the maximum number of hogs eligible for subsidy. Work could also be undertaken to estimate the cost and effects of a program that would limit payments to 100 or 200 barrows and gilts per producer, rather than to 100 or 200 hogs from any slaughter class. It may be possible to evaluate programs that would limit payments to a uniform, maximum number of hogs per producer more effectively when more recent census data become available.

The relative cost of the quota program was quite low and, for this reason, may be thought to hold a considerable amount of promise. Work needs to be done, however, on more refined ways to estimate stable future pork supplies.

Possibly the quota could be modified and established on the basis of historical farrowings rather than of hog marketings. A producer could receive direct payments for all hogs marketed from the farrowings of the sows eligible under the quota. No producer would be penalized for the efficient practice of raising an above-average number of pigs per litter.

The estimates of the costs of the previous programs were determined primarily by the support prices used. Other support levels and methods of support need to be examined to obtain cost estimates under alternative support procedures.

Experiments like that of the 1955 Ohio experiment (45), but with more hogs, would be helpful in determining the performance of hogs and the most profitable weight at which to market hogs, etc. Another experiment could be conducted at the farm level where the farmers would be selected at random, ranging from poor to good managers, from different parts of this state or in different parts of the Corn Belt. The farmers could be asked to keep an accurate check on the amount of feed fed to hogs, but the experiments should be conducted for a long enough period so that a record of performance could be obtained under a variety of conditions that are likely to occur in different years, with different weather conditions and different qualities of corn, etc.

Hogs To Be Used

A few common breeds or types of pigs should be selected and the experiment confined exclusively to them to eliminate the possibility of confounding results with differences in breeds and types of pigs.

A sizable number of pigs should start the experiment in the same month and at the same age, as nearly as possible. Atkinson and Klein (1, p. 5) based their work on information obtained from 813 pigs in five experiments in the Corn Belt; however, the Ohio experiment included only 10 hogs (45). The pigs should be carried to at least 300 pounds and perhaps more, until it was shown definitely that it was unprofitable to do so under all circumstances.

Ration To Be Used

The ration should be of high quality and comparable to those used in current efficient operations. The results should be recorded weekly to obtain precision.

Determine Total Cost in the Future

Estimation of total cost of the incentive-payment program for future years should be made. This would require an estimate of total marketings and an estimate of the percentage of barrows and gilts marketed under the maximum weight limit that could be set by the government. The estimation of total marketings would require some knowledge of the percentage of farmers participating in a program of this type. Some knowledge of the probable increase in the number of hogs produced in the first and in subsequent years also would be required. If the increase in the number of hogs produced is fairly large, and if a fairly large number of farmers participate in the program, some adjustments in the incentive payments determined in this study might need to be made. This would be especially true if an experiment similar to the one suggested were conducted and if the results showed the performance of the hogs to be significantly different from that for hogs used in the present study.

CONCLUSIONS

The chief objective of the direct-payment programs considered in this report is to increase hog producers' incomes by reducing the total supply of pork. The analyses of several different programs lead to these conclusions:

1. *A program that would limit payments to 100 or 200 hogs per producer.*

Assuming a direct payment of $2 per 100 pounds, the cost in 1954 (the latest year for which census data are available) of a program limiting payments to 100 hogs per producer would have been about 229 million dollars. If the limit had been set at 200 hogs per producer, the cost would have been about 268 million dollars, and, if no limit had been set, the cost would have been about

286 million dollars. In all three cases, the programs would have increased hog producers' incomes by the same amount.

Under this kind of program, small producers would be inclined to increase their production toward the number of hogs eligible for payments, while large producers, anticipating lower prices for that reason, would be inclined to reduce their production. It is difficult to estimate what the net effect on production would be.

2. *A program to restrict payments to a national quota distributed pro rata among hog producers.*

This type of program would have effects proportional to the size of the quota. Using quotas based on the estimated pork supplies for 1959 and apportioned on the basis of historical marketings, the cost of payments for 1959 would have been about 110 million dollars. The payment procedure used in the calculations is similar to that used in the Canadian program. The support price used is 80 percent of the United States average price of hogs for the 10-year period from 1949 through 1958, or $14.70 per hundredweight. The estimated weighted average price of hogs in the United States in 1959 is $14.07 per hundredweight. Therefore, payments are figured at 63 cents per hundredweight for all hogs sold under quotas.

The quota calculated for 1959 is 12 percent less than actual marketings. Using an estimate of elasticity of demand for hogs at the farm level of −0.4, the value of the smaller quota marketings is about 11 percent greater than the actual value of hog marketings during 1959. This increase in hog producers' incomes would have come from consumers in the higher prices they would pay for less pork and in the additional cost of other foods they would buy instead of pork. The long-run effects would depend, of course, upon how well the quota restrictions could be enforced.

3. *A program to restrict payments to lightweight hogs.*

If this program induced all farmers to sell their barrows and gilts at or below 200 pounds, the total tonnage of barrows and gilts would be reduced by about 15 percent. This would increase the total value by about the same percentage.

But it is unlikely that the payments could be large enough to induce all farmers to participate, and the increase in the market supplies of lightweight hogs would depress their prices relative to the prices of heavy hogs. That would offset part or all of the payment. Accordingly, it is difficult to estimate benefits and costs for this program accurately. It seems likely, however, that the end result would be more hogs, at lighter weights, with total hog returns about the same as they were before the program, since no change would have taken place in the over-all competitive conditions that determine total returns.

It has also been demonstrated in this study that a change in the price of hogs exerts a distinct influence on the profitable weight to which hogs should be fed. In addition, it has been demonstrated that feed prices have an effect on the weight to which a farmer can carry his hogs to maximize the profits he can make on his hog enterprise. Remember, however, that the optimum marketing weights calculated in this study for prior years are those at which an *individual* producer could have maximized his returns. If *all* producers had marketed at these optimum weights, then the price-supply relationship would have changed and, with it, the optimum marketing weights.

Seasonality in prices and costs has been shown to be of utmost importance in the determination of the weight at which to market hogs most profitably. Some of the conclusions drawn from the present study on seasonality follow:

(a) For the period, 1947-59, highest prices occur during June, July and August, with September prices declining only slightly. The prices break in October and reach a low point in November or December. Prices gradually rise from January through July. During the period 1930-41, however, Atkinson and Klein (1) found that prices showed a late winter peak and an early spring decline. The later winter peak and early spring decline have been eliminated in more recent years. Thus, the seasonality of prices has changed over the years.

(b) Data on how heavy to feed the hogs in different time periods during the year also are useful to farmers. For example, for the years 1955-59 when a moving-average price was used, it was profitable to carry the hogs to 210 pounds when the farrowing date was Feb. 15, but it was profitable to carry the hogs to 285 pounds when the farrowing date was Sept. 15.

(c) Pigs farrowed in February and March could be marketed more favorably at lighter weights than at heavier weights. For pigs farrowed in April (the peak spring farrowing month), not much of a price discount is noted for heavier weights, whereas May and June pigs bring higher prices at 240 and 270 pounds. July pigs can usually be carried to heavier weights, and so can October pigs. But November pigs farrowed early in the month show an advantage at 240 pounds over the 270-pound weight. For pigs farrowed later in November, the 270-pound pigs have the profitability advantage over the 240-pound pigs.

(d) Price differentials for hogs at different weights proved to be quite important in the present study. Results indicate that this factor alone could determine whether or not it was profitable to carry barrows and gilts to heavier weights. The price differential became of minor importance in some periods because the demand for heavier hogs narrowed the price differential. The producer should take this factor into account in planning the hog program on his farm.

Prices of feed generally declined toward the end of the year and, thus, caused the incentive payments to be somewhat higher than they would have been had the feed prices been stable. In general, however, the difference in prices of feed from time to time was relatively small and, therefore, had a much smaller effect than did changes in hog prices.

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