LAGGED RESPONSE IN SELECTED PORK PRICES

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ABSTRACT

LAGGED RESPONSE IN SELECTED PORK PRICES

by James G. Snell

Various pieces of literature have advanced the idea that pork prices at the retail level lag behind those at farm or wholesale level. They indicate that the length of this lag depends upon (1) the pricing policies of the retailers and (2) the direction in which prices are moving.

Since the main short run price determining point is at the packer or wholesale level, it was assumed that if a lag existed it was partially due to imperfect knowledge on the part of retailers. Therefore, no lag was expected between farm and wholesale levels but that there would be a lag between farm and retail and wholesale and retail levels.

The data used were average weekly data, consisting of prices of selected cuts at retail and wholesale levels, farm price and quantity of U.S. 1, 2 and 3 barrows and gilts, and farm quantity of U.S. Choice beef. All of these prices and quantities were taken at Chicago with the exception of the retail prices which were taken from the

M.S.U. Consumer Purchase Panel.

The various prices and quantities were fitted by regression equations of the following form for determination of the proper lag:

$$\text{Set } j \quad \begin{array}{ll} (Y_i)_t = (a + b_i Z_i + b_i Q_i + u)_t & j.0 \\ \quad \cdot \qquad \cdot \quad \cdot \quad \cdot \quad \cdot & j.1 \\ \quad \cdot \qquad \cdot \quad \cdot \quad \cdot \quad \cdot & j.2 \\ (Y_i)_t = (a + b_i Z_i + b_i Q_i + u)_{t-3} & j.3 \end{array}$$

where Y_i = a given price of a specific cut one level above that price used as an independent variable; Z_i = either farm or wholesale price of a specific cut, depending on the lag being determined; Q_i = farm quantities of pork and beef; j = a specific set of equations; t = observation period of the variables; and the number following the j = the number of observation periods the independent variables are lagged behind the dependent variable.

The equation having the largest R^2 in a set was tested by the F ratio test to determine whether the $\hat{S}_u^2$ (estimated variance of the U's) of this equation was significantly smaller than the $\hat{S}_u^2$ of the other equations in the same set.

After the preceding equations were calculated, a dummy variable which denoted the direction of the change in Z_i from t to t+1 was added to the equations to determine whether the direction of the price change influenced the lag. An F ratio test was made to determine whether the $\hat{S}_u^2$ of the equation using the dummy variable was significantly smaller than the $\hat{S}_u^2$ of the equation not using the dummy variable.

Margins were computed on a lagged basis and fitted as functions of various prices and quantities of hogs.

When computed on an over-all basis, which made no distinction between upward and downward price movements, there appeared to be a one week lag in farm to retail prices and in wholesale to retail prices.

When the dummy variable approach was used, the dummy variable seemed to have no significant value. This indicated that there is no difference in lag between a rising and a falling market. Because of this, the assumption of the lag being based on a knowledge situation loses validity.

The margins proved to have no positive value when formulated on a lagged basis.

The conclusions reached were (1) there is no lag between farm and wholesale prices; (2) there is a one week lag between farm and retail prices and between wholesale and retail prices; (3) there was no difference in lag between an upward and a downward market; and (4) margins cannot be explained by price and quantity alone.

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By

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CHAPTER I

INTRODUCTION

Purpose

The purpose of this thesis is to examine the lagged response of retail pork prices to price changes at either the farm or wholesale level. It does not attempt to predict prices or margins at any level and, therefore, does not use complete statistical or economic models. A secondary purpose is to view the effect on margins of the lagged response in a changing price situation.

Previous Studies

In 1943 Little and Meyers attempted to determine the time lag between farm, wholesale and retail prices of certain selected foods.[1] This study was concerned with the fact that price freezes by the Office of Price Administration could either exert "squeezes" or "abnormal profits" on certain segments of the industry. In determining the lag,

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[1] Herschel W. Little and Albert Meyers, Estimated Lags Between Farm, Wholesale and Retail Prices for Selected Foods, U. S. Department of Agriculture Monograph (Washington, 1943), p. 1.

Little and Meyers used monthly data; however, they stated "The ideal data for this purpose would have been weekly average prices."[2]

The first step in the above study was to run simple correlation coefficients on farm-retail and wholesale-retail price spreads at various lagged periods. Then by interpolation the proper lag was computed and a lag of 2 to 3 weeks was found for pork. Checks were run using bimonthly data which indicated that the interpolation was correct. A large influence was exerted by changing prices. When prices were rising, there tended to be little or no lag; for price decreases, retail prices seemed to lag by approximately one month. The study also included a distributed lag equation which also supported a lag period.

Little and Meyers used a composite figure for retail price of pork, which included both fresh and cured pork. The farm price used was the price received by farmers multiplied by 1.9 since 1.9 pounds of live hog produces approximately one pound of retail pork.

They found that their results were not conclusive, but they hoped that their study would stimulate further study in a largely neglected field. After searching through

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[2] Ibid., p. 4.

considerable literature, this writer feels that it is still a neglected area.

Another contribution to the estimation of lagged price relationship of pork was made by Stout and Feltner. Their purpose was to study differences in country and terminal market prices and farm level and wholesale value in a lagged relationship. For this study they used data from September 14 to 25, 1959; November 30 to December 11, 1959; and February 15 to 26, 1960. They found, using simple regression, that there exists a higher relationship between unlagged prices than lagged prices. They obtained an R^2 of .884 on an unlagged basis and .857 on a one day lag.[3]

Another area which is concerned with lags is the study of margins. Of the existing studies, Pork Marketing, Margins and Cost[4] is an example. This study was concerned with marketing margins and costs affecting them. No attempt was made to determine the lagged relationship though the publication pointed out that lag in price changes cause some of the widening and narrowing of the margins associated

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[3]Thomas T. Stout and Richard L. Feltner, "A Note on Spatial Pricing Accuracy and Price Relationship in the Market for Slaughter Hogs," Journal of Farm Economics, XLIV (February, 1962), p. 217.

[4]Pork Marketing, Margins and Cost, U.S. Department of Agriculture Miscellaneous Publication No. 711 (Washington, 1956), p. 3.

with pork prices. In determining the margins, average monthly prices were used. The farm and wholesale prices were obtained from Chicago; the wholesale price being computed by Livestock Market News from National Provisioner data. Farm price was for 200 - 220 pound barrows and gilts.

These studies still leave a wide area in which a weekly price series could be used to determine the lag in retail pricing and the degree to which this lag influences margins.

Usefulness of Results

The results of this thesis may be helpful in explaining the fluctuations of margins in pork pricing. It may also be helpful to the retail trade by showing how a better knowledge of the pricing situation at a lower level could decrease fluctuations at the retail level. This thesis also serves the purpose of gathering together weekly average prices over a seven year period which could be used in a more detailed and sophisticated approach to retail price prediction.

CHAPTER II

GENERAL THEORY

Introduction

This section is devoted to the presentation of the general theoretical concepts that can be considered to underlie the pork market. It is these theoretical concepts that lay the basis for the lag study to be presented in later chapters.

Supply and Demand

In static economic theory,[1] supply and demand schedules or curves are maximum concepts.[2,3] The demand

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[1]For the assumptions that make the system static see Appendix I.

[2]Notes on lectures in Price Theory given by Milton Freidman, January to June, 1951, in Economics 301 and 302, University of Chicago, p. 9.

[3]While this author prefers to consider supply and demand to be maximum concepts, a substantial number of economists consider them to be exact concepts. That is, demand can be defined as the quantity or quantities of a product or service buyers are willing and able to take at a given price or series of prices. Similarly, supply can be defined as the quantity of a product or service that would be made available to buyers at any one of the specified series of prices if such a price were offered. It will be noted that these definitions require only ability and willingness to buy or sell and that no actual transactions are required.

schedule or curve represents the maximum quantity per unit of time that the consumer will take at various prices; stated in another way, the demand curve shows the maximum prices consumers will pay for different quantities per unit of time. The supply schedule or curve represents the maximum quantities per unit of time that the sellers will place on the market at various prices, or the minimum prices which will induce suppliers to place various quantities on the market.[4]

The resulting prices may be termed the supply and demand prices.[5] The supply price may be viewed as the price the producer must receive before he will deliver the good. The price the producer receives for his product must be sufficient in the long run to cover the cost of production plus a normal profit. Since most production is carried on under increasing costs, the larger the quantity, the larger the price that is needed to keep the quantity forthcoming, i.e., supply price increases as quantity supplied increases.

The demand price concerns the utility of the product

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[4]Richard H. Leftwich, The Price System and Resource Allocation (New York, 1961), pp. 28-31.

[5]A. Marshall, Principles of Economics, Book 5 (New York, 1922), pp. 323-503.

to the consumer. It is the maximum price the consumer is willing to pay for a given quantity; at a higher price, the marginal utility of the good is less than the marginal utility of the money the product cost. The consumer may buy a smaller quantity at the same price or a larger quantity at a lower price; demand as a maximum concept does not prevent this. Just as production is usually carried on under diminishing returns, so is a product subject to diminishing utility. As the quantity obtained increases, the utility of each additional unit (marginal utility) decreases, and the larger the quantity, the smaller the demand price will be.[6]

The demand and supply price may be summarized in the following manner: the demand price is the price the good will actually bring in the market; the supply price is the price the producer must receive for his product to continue production of the quantity indefinitely.[7]

The normal or standard approach is to consider price as the independent variable and quantity as the dependent one. In this approach, price changes as quantity being

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[6]Friedman, pp. 35-43.

[7]Kenneth E. Boulding, Economic Analysis (New York, 1955), p. 114.

demanded changes and this results in the quantity supplied being varied according to the demand price. This is an intermediate or long run situation.

Marshall used the quantity independent-price dependent approach which is a short run situation where a given quantity brings forth a given price. In this, quantity assumes the more dominant role and is not considered to be "controlled" by price. This approach is also substantiated by Working, who said, "From the standpoint of the entire market, however, meat supplies determine prices rather than the other way around. This refers, of course, to relatively short run situations."[8] In this paper, because of the predetermined supply, the quantity independent-price dependent approach of Marshall will be used.

Production

In looking at distributed lag response in hog production, Ferris found that in the period 1925 to 1941, the supply of hogs was almost entirely determined by the prices of hogs in the preceding fall farrowing time.[9]

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[8] Elmer Working, Demand for Meat, Institute of Meat Packing (Chicago, 1954), p. 8.

[9] John N. Ferris, Dynamics of the Hog Market with Emphasis on Distributed Lags in Supply Response (unpublished Ph.D. thesis, Michigan State University, 1960), p. 151.

For the period 1947 to 1958, the prices received during the fall farrowing and the prices the preceding fall were significant in determining the supply of hogs the following year. This indicates that the supply of hogs on the market at any given time is not a significant function of the prevailing price, but rather a function of factors in the two preceding years.

Production is for all practical purposes, fixed at its upward limit once the sows are bred.[10] Production may be gauged downward by selling the sows, but they are normally discounted if the pregnancy is visable. Marketing time is also essentially fixed because of the nature of the hog. Feed represents 84% of the total production cost of hogs;[11] so economies practiced in feeding represents one of the best ways of cutting the variable cost involved in producing hogs. This fact exerts a large influence on the marketing time. Hogs make their most rapid gains from 200 to 225 pounds.[12] This is at the top of the weight range

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[10] Arthur A. Harlow, "The Hog Cycle and the Cobweb Theorem," Journal of Farm Economics, LXII, No. 4 (November, 1960), p. 848.

[11] W. E. Carroll and J. L. Krider, Swine Production (New York, 1956), p. 198.

[12] Ibid., p. 207.

that packers prefer;[13] it is usually considered unprofitable to feed the hogs to a heavier weight because each additional pound of gain is obtained at increasing quantity of feed per pound of gain.[14] Therefore, marketing time is largely predetermined by the nature of the product. It may be put off two or three weeks, but this is usually considered the practical limit.[15]

The hog market is characterized by a predetermined supply that must be marketed in a relatively small range of time, i.e., an inelastic supply curve for hogs. It is this interaction of the more elastic demand curve and the inelastic supply curve that determine the price of pork; price is set by the available supply.[16] This can be considered a quantity independent and price dependent market.

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[13]P. Thomas Ziegler, The Meat We Eat (Danville, Illinois, 1958), p. 47.

[14]Of course, there will be times in which it will be profitable to feed hogs to either a lighter or heavier weight. This will depend on many factors. (See "How Heavy Should I Feed My Hogs?," Agriculture Situation, 1949). But other things remaining equal, 200 to 225 pounds is normally considered the most profitable weight.

[15]Karl A. Fox, The Analysis of Demand for Farm Products, U.S.D.A. Bulletin No. 1081 (Washington, 1953), p. 23.

[16]This is the convergent case of the Cobweb Theorem where price is determined by the intersection of the demand curve with the inelastic supply curve.

The Market

> A competitive market may be defined as a large number of buyers and sellers, all engaged in the purchase and sale of identically similar commodities, who are in close contact one with another and who buy and sell freely among themselves.[17]

Perfect competition requires an additional criteria of perfect knowledge. It is generally agreed that no market is truly perfectly competitive. It is assumed that many markets may be classified as such for the purpose of analysis. Whether or not the packing industry[18] can be considered competitive has been debated. Nicholls stated that there is evidence of dominance and price leadership among the meat packers, but they have not resorted to aggressive pricing actions among themselver or toward the smaller firms.[19] Actually they have followed market sharing with buying prices that approach the collusive-oligopsony level. Williams, on the other hand, says that the changes that have occurred since Nicholls' study have brought the packing industry

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[17] Boulding, p. 45.

[18] The meat packing industry was defined by Williams to include all packing (slaughtering) plants, packer branch houses, independent wholesaling distributors and procurement operations of retailers.

[19] William H. Nicholls, Imperfect Competition Within Agriculture Industries (Ames, Iowa, 1941), pp. 114-131.

closer to perfect competition.[20] He cites improved transportation, better knowledge and decentralization as some of the causes.

Buyers and Sellers

At the farm level the number of sellers meets the requirement for a competitive market. In 1959, there were 1,846,758 farms producing hogs.[21] None of these sellers are large enough to influence prices by their own action, except by the quality of their hogs. The number of farms on which hogs are produced varies with the fluctuation of hog prices. The farmer tends to stay in a declining market, once he is producing, for a longer time than is required for farmers to enter the market when the price is rising. Even with this fluctuation in number of farmers, there is still a relatively large number of sellers at all times.

The packing industry, on the other hand, is characterized by dominance of a few large firms with many smaller local firms.[22] In the past, the large firms have operated

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[20]Willard F. Williams, "Structural Changes in the Meat Wholesaling Industry," Journal of Farm Economics, XL (May, 1958), pp. 317-338.

[21]U.S. Department of Commerce, Bureau of Census, Census of Agriculture for 1959-Preliminary (Jan., 1961), p. 14.

[22]Williams, pp. 315-329.

rather large centralized slaughtering plants. In recent years, there has been a trend toward decentralization, with smaller more efficient plants. At the same time, the percent of total slaughtering done by the four largest firms has been declining; while small local plants have increased in number by nearly one-third.[23]

The situation could be likened somewhat to the example used by Stigler of two-piece men's suits with knickers where 78% of total output was produced by four main firms. However, there were 144 firms making two-piece suits without knickers.[24] Had it become very profitable to make knickers, the other firms could have begun to produce them. In the meat industry, there are many small firms, some of which operate plants that are relatively efficient and not subject to the large fixed cost which faces the larger national firms. Many of these smaller plants produce specialty items such as luncheon meat, sausage, etc. However, if it became abnormally profitable to sell meat by the wholesale cut to retailers because of pricing policies of the dominant firms, the smaller firms could enter into the

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[23] <u>Ibid</u>., p. 329.

[24] George J. Stigler, <u>The Theory of Price</u> (New York, 1952), p. 13.

sale of the cuts in their own locality and force the national firms to reduce their prices to regain their business.

If this can be considered to be relatively true, then dominance of the large firms becomes of less importance as long as they take only normal profits and act in a relatively competitive manner. Even though the number of buyers does not fit the perfectly competitive model, the situation is such that it will be assumed that a competitive model will not be too far removed from reality for the purpose of analysis.

At the retail level, there are enough buyers of wholesale meat to assume perfect competition. Although chain stores sell approximately 38% of the meat sold,[25] there are many smaller local chains and neighborhood food markets that sell fresh meat.

The pricing situation at the retail level is usually quite competitive. There may be price leaders in a given area, but if these leaders follow a policy of pricing that is too far removed from the competitive equilibrium, other stores will force the leaders to adjust their prices more in line with what the competitiveness of the situation dictates.

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[25] Facts in Grocery Distribution (Progressive Grocer; 1958), p. F-3.

Price reductions may be accomplished for the purpose of a "leader" or "drawing card" by certain stores, but this is a short run condition. If price reductions were to continue, other stores would also lower prices; this in turn would force all into a cutthroat situation, which would be unprofitable to all involved.

Homogeneity of Product and Discrimination

Homogeneity of pork can generally be assumed. The establishment of U.S.D.A. grades and federal inspection has made product differentiation difficult. The various packers have established their own standards and attempted to persuade the consumer of product difference. This is complicated to a further degree by large chains (chains are defined as eleven or more units) establishing their own grades. Beef grades probably have a wider range of consumer knowledge than pork grades do. Although there has been an attempt to persuade the consumer of product difference, the consumer has little real basis for discriminating against pork on the basis of who processed it.

It can also be assumed that there is relatively little discrimination in buying and selling. In certain cases, packers may pay somewhat more for hogs from a certain producer but this is because of the quality of the hogs which that farm produces. The packer will sell to anyone; the larger the quantity the lower the price. This cannot be considered discrimination, but a saving in cost from selling in volume business. The price that faces the consumer does not vary because of discrimination.

Knowledge

There will never be perfect knowledge or foresight. In this knowledge aspect, the farmer has the least perfect knowledge of the three groups: farmer, wholesaler, or retailer. This limitation has been alleviated somewhat through daily radio reports, newspapers, and market outlook studies done by various institutions. At the beginning of production, the farmer has only a vague idea as to the quantity of hogs that will be produced by other farmers. By the time feeding starts, he has a better knowledge of the situation and has some basis for a decision as to the weight and speed at which he will feed his hogs. At market time, again he has only a general idea as to the price he will receive if he ships to a terminal market. Once the farmer has committed his hogs to the terminal market, he has little choice but to sell. He has become a price taker.

The declining percentage of hogs being sold on the terminal market and the increasing percentage being sold directly or locally may be an indication of the fact that the farmer recognizes the limitation he faces in the knowledge situation. By selling locally, he can limit sales to those hogs that meet the proper weight, reduce his marketing cost and pick a day on which the price seems most agreeable or advantageous to him. He has placed himself in a situation that entails more bargaining. Even though the price he receives is usually less than he would have received on the terminal market, his costs may also be less and the local market enables him to put off marketing for a short time without incurring additional costs. This removes the farmer from the position of having to sell once he places his hogs in the terminal market.[26]

Packers could find this somewhat advantageous also. They are not faced with such an inelastic supply curve; by increasing their prices, they obtain more hogs on a given day. The market is still a quantity independent-price dependent one, but for any given period the supply is less inelastic. The packer still has the knowledge of his costs

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[26] A. A. Dowell and K. Bjorka, Livestock Marketing, 1st Ed. (New York, 1941), pp. 148-150.

and how much he must receive for the product at the wholesale level. Because of the time in operation, the national packers usually have a relatively good idea of the demand curve they face. Since they know the wholesale price they can expect to receive and their costs, they know how much they can pay for the factor of production, hogs, to make a profit. When viewed in this manner, the farm price becomes a residual and the farmer becomes a price taker. However, this is a short run situation. In the long run, it is still the interaction of supply and consumer demand that decides the equilibrium price and quantity of hogs.

Because of changing supply due to the hog cycle, the hog market is not in equilibrium. Packers would prefer a relatively constant supply of hogs. If the packer can obtain a stable supply throughout the production year, he will be able to build a plant of optimum size for his particular needs and operate at minimum cost. Actually, the packer must have a plant that has excess capacity in periods of slack supply and under capacity during peak supply. This situation makes for relatively large average total cost and is reflected to a certain degree in the nature of margins and how they act under various supply conditions.

Just as packers prefer a more constant supply, so do retailers. Retailers believe that consumers would rather have stable than fluctuating prices. They, therefore, desire stable supplies because of the stable prices that should follow. Retailers also prefer to change price in a downward manner rather than in an upward direction.[27] But the cost of a mistake in not raising prices when they should will normally be greater than the cost of not lowering prices when possible. Therefore, when prices are dropping, retailers tend to wait for a trend to be established but respond rather rapidly to an upward price movement. This tends to cause an alternating widening and narrowing of the retail margin.[28]

The degree of knowledge possessed by the various participants in the market affects the fluctuation of the margins and causes the lag in retail price adjustment to changing supply of hogs. If the retailer bases mark-up on replacement cost, his prices will change with or lag behind wholesale price, depending on how often he buys meat.[29]

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[27] Little and Meyers, p. 2.

[28] George Motts, Marketing Handbook for Michigan Livestock, Meats and Wool, MSU Agricultural Experiment Station, Bulletin 426, p. 30.

[29] Little and Meyers, p. 3.

The wholesaler knows with a large degree of accuracy what price he must receive for the pork to make a profit. Therefore, one would expect to find very little lag in wholesale price adjustment to changing supply relative to the lag in retail price adjustment. However, U.S.D.A. Miscellaneous Publication No. 711 indicated that wholesale prices lagged behind farm prices during sharply changing supply.[30] This is in opposition to the findings of Stout and Feltner,[31] and to the hypothesis of this thesis. The difference may be due to the fact that Miscellaneous Publication No. 711 used prices of 200 to 220 pound hogs while Stout and Feltner used 180 to 270 pound hogs.

There may be lags in wholesale pricing for one particular weight of hogs, but there should be no lag when considering all weights. Packers or wholesalers may take a negative margin on certain weights but could not do so for all weights.

Stout and Feltner found that there was a higher degree of association between live hog value and wholesale value on an unlagged basis than on a lagged one. They also

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[30] U.S.D.A. Miscellaneous Publication No. 711, p. 3.

[31] Stout and Feltner, p. 214.

found that while wholesale value may influence farm price in the long run, wholesale value had little effect on farm price on a day-to-day basis.[32] This agrees with Haas and Ezekiel in the finding that the general trend influences farm prices more than day-to-day changes.[33] Little and Meyers said on the basis of a priori knowledge that a lag in price changes is to be expected and that the lag would be different in a rising market than in a lowering one.[34]

Summary

> What the consumer can be induced to pay for meat he buys is the final fact which limits the price which the retailer can pay at wholesale; and the price for which the product can be sold at wholesale limits the price which packers can pay for the live hog.[35]

Since hog supplies change more than does consumer demand, the focal point in pricing pork and live hogs is at the packer buying level where the change is first felt.[36] As stated before, a priori knowledge indicates there will be a lag in retail price response to supply changes. The

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[32] Ibid., pp. 217-218.

[33] G. C. Haas, and Mordecai Ezekiel, Factors Affecting the Price of Hogs, U.S.D.A. Bulletin No. 1440 (Washington, 1926), pp. 10-11.

[34] Little and Meyers, p. 4.

[35] Haas and Ezekiel, p. 7.

[36] U.S.D.A. Miscellaneous Publication No. 711, p. 21.

interest of this thesis is centered in this lag. The fact that margins tend to widen during times of large supply and narrow during times of small supply seems to indicate margins and the adjustment lag are related. Therefore, a secondary interest is focused on margins.

CHAPTER III

DATA AND METHODOLOGY

Data Source

The M.S.U. Consumer Purchase Panel was chosen as the source for retail prices of pork as this purchase panel offered an unbroken seven year period with which to conduct this study. The M.S.U. Consumer Purchase Panel was a group of 200 to 250 Lansing, Michigan, families who kept detailed records of their food purchases.[1] The Panel was started in February, 1951, but it was late in 1951 before as many as 200 families were reporting. Certain inaccuracies in their reports may be present, but this source is probably the best presently obtainable for the type of study to be conducted.

The farm and wholesale or packer level data was obtained from the U.S.D.A. Market News,[2] which is a weekly

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[1] The Panel was under the direction of Dr. G. G. Quackenbush and Dr. James D. Shaffer. For methodological problems of organizing and operating the panel consult James D. Shaffer, Methodological Basis for the Operation of a Consumer Purchase Panel (unpublished Ph.D. thesis, MSC, 1952).

[2] U.S.D.A., Livestock, Meat, Wool; Market News; Weekly Summary and Report, 1952 through 1958.

publication. The prices were those of Chicago as it was felt that Chicago prices would most accurately reflect prices in Lansing.[3] Chicago is generally recognized as the wholesale pricing center for the Midwest and Lake States, much as New York is the pricing center for the East. The U.S.D.A. publication was chosen because it gave weekly averages, whereas many publications issue only monthly reports. Since the lag is assumed to be relatively short, it was thought that weekly data could more accurately estimate the correct lag.

The wholesale value figure was compiled by the U.S.D.A. from data taken from the National Provisioner. The wholesale value is a composite value per cwt. of the edible portions.

By using data from the M.S.U. Consumer Purchase Panel and the U.S.D.A. Market News, weekly averages were directly obtainable. Not only were the weekly average prices given, but all the time periods used by each source were identical except in the case of farm price and quantity of beef which were lagged two days behind the other variables. These appeared to be the two most logical data sources.

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[3] Harold M. Riley, Some Measurement of the Consumer Demand for Meats (unpublished Ph.D. dissertation, Michigan State College, 1954), p. 159.

Choice of Prices

In choosing the retail cuts to be used, it was decided that pork chops and roasts would be the retail cuts most likely to show the minimum lag. The retail cut of pork chop comes from the loin and roasts usually from the loin or butt. These wholesale cuts of loin or butt are usually sold immediately to the retail trade.[4] Ham, picnics and other cured meat cannot move directly into the retail trade because of the curing time. Also, these cured cuts have a longer storage life and may be carried from fall and winter into the spring and summer more easily than fresh pork.[5]

Fresh pork may be frozen and stored in this manner, but the freezing qualities of pork are not conducive to long periods of storage; frozen cuts usually are sold at a discount. This is due to the nature of fresh pork fat which contains a double bond hydrocarbon chain. These double bond chains are subject to cleavage by oxygen. When cleavage occurs, aldehydes and fatty acids are formed which generally are considered to have a detrimental effect on the palatability of pork.[6]

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[4] Ibid., p. 17.

[5] Ibid.

[6] Ziegler, p. 192.

The better storing qualities of cured meat may cause the lag to be "blurred" in that supply changes at the farm level could be absorbed in packer storage and held for sale in low supply periods. This is especially true of canned ham and picnics.

It was felt that the listing of the cuts by the purchaser for the M.S.U. Consumer Purchase Panel would be more accurate for pork chops and roasts than for many other cuts. The ambiguousness of ham and picnic ham is very conducive to an inaccurate list as to what was actually purchased. This inaccuracy is eliminated to a large extent for this study by the wide consumer knowledge as to what is a roast or a pork chop.

At the wholesale level the total value per cwt. of pork was used as well as the price of specific wholesale cuts. Loins were chosen as they are the most accurate for an investigation of pork chop price changes. Butts were also included because both loins and butts are good sources of pork roast.

At the farm level, the aggregate average value of U.S. No. 1, 2, and 3 barrow and gilts as compiled by the U.S.D.A. was chosen to reflect average changes in all pork. The quantity of U.S. choice steers at Chicago was used as a measure of the quality of beef. Steers of choice grade consistently represented over 50% of the top three grades of steers sold. Heifer prices were highly correlated with those of steers.

Methodology

In analyzing the data, both graphic analysis and least squares regression techniques were employed. It is the assumption of this thesis that the lag could be found by calculating regression models with the predetermined or independent variables lagged at various time periods. The model that obtains the highest coefficient of determination (R^2) would be accepted as representing the correct lag. At the same time, simple graphic analysis would be very helpful in indicating what the correct lag should be.

The various statistics were collected and punched on cards. Each card held one observation with each observation being prices and quantities for one week. Each year contained fifty-two observations except 1954 which had fifty-three. The manner in which the weeks were arranged was the reason for the latter number. This presented no particular problem as this writer was aware of the fact at the beginning of the 53rd. observation was handled as any other observation. The punched cards were then placed in MISTIC, the M.S.U. electronic computer, to estimate the various regression models. Since in some regression models a variable may be independent and in others dependent, all variables were designated as X's when normally some would be Z's (independent or predetermined) and others Y's (dependent or endogenous) in the standard regression notation. This is only a form of notation.

The general notation is as follows:

P = price	f = farm	p = pork
Q = quantity	w = wholesale	b = beef
	r = retail	l = loin
		s = butt
		c = pork chop
		r = roast

t = observation period or week

P_{r_c} - Retail price of pork chops

P_{r_r} - Retail price of pork roast

P_{f_p} - Farm price of pork

Q_{f_p} - Farm quantity of pork

P_{w_p} - Wholesale value of pork

P_{w_l} - Wholesale price of pork loin

P_{w_s} - Wholesale price of butt

Q_{f_b} - Farm quality of beef

In the above notations, the first subscript designates the level (farm, wholesale, or retail) and the second subscript designates the particular item. The subscript t designates the observation period of the variable in question. A lag of one week is designated as t-1; a lag of two weeks is designated as t-2, etc.

Lags

The regression equation was written in the following manner:

$$(P_{w_p})_t = (a + b_1 P_{f_p})_t$$

This would not be the "best" model to use to predict prices as such things as wage rates and the general economy all influence prices. However, it was felt that the possible inadequacy of this equation would not be sufficiently large to invalidate the resulting estimates of the coefficients or the coefficient of determination for the purpose of this thesis.

Graphic analysis was used to approximate the lags involved. This was helpful in choosing the approximate lag to use in the equations. The various prices and quantities being considered were plotted against time. By visual inspection of the peaks and valleys, it was possible to determine whether a lag was to be expected or not. After the coefficients of the lagged equations were estimated the resulting R^2 were plotted against time for a visual inspection of the lag.

The lagged equations are of the following form:

$$(P_{r_c})_t = (a + b_1 P_{f_p} + b_2 Q_{f_p} + b_3 Q_{f_b})_t \qquad j\text{-}0$$

$$\cdot \quad \cdot \quad \cdot \quad \cdot \quad \cdot \qquad j\text{-}1$$

$$\cdot \quad \cdot \quad \cdot \quad \cdot \quad \cdot \qquad j\text{-}2$$

$$(P_{r_c})_t = (a + b_1 P_{f_p} + b_2 Q_{f_p} + b_3 Q_{f_b})_{t-3} \qquad j\text{-}3$$

where j = a particular number of an equation or a set of equations and the number following j designates the number of observation periods the independent variables have been lagged for that particular equation in the j^{th} equation or set.

This is the general format. Other prices were substituted to obtain the lag for other cuts or price levels. The equations were calculated for the combined seven year period.

When the equations were calculated, the results were checked by the F ratio to see whether the equations were significantly different where P = .05. The lags were tested and cross tests were made to see if different cuts or prices indicated different lags. The F ratio test was made using the sum of residuals squared as calculated by the electronic computer with the appropriate degrees of freedom. By dividing the sum of the residuals squared by the degrees of freedom associated with it the estimated variance of the residuals or U's ($\hat{S}_u^2$) is obtained.

$$\frac{\Sigma(Y - \hat{Y})^2}{d.f.} = \hat{S}_u^2$$

To test to see if there is a statistical difference between equations the smaller $\hat{S}_u^2$ is divided into the larger $\hat{S}_u^2$. This will give an F ratio. This will test to see if the smaller $\hat{S}_u^2$ is significantly smaller than the other $\hat{S}_u^2$ used in computing the F ratio. If $\frac{\hat{S}_{u_i}^2}{\hat{S}_{u_j}^2}$ is greater than the F table critical value then the hypothesis is accepted that the smaller $\hat{S}_u^2$ is significantly smaller than the larger $\hat{S}_u^2$. However, if the computed F value is smaller than the critical table value the hypothesis that there is no statistically significant difference is accepted. By this method it was determined whether lags were present and whether the equations were changed significantly by lagging the independent variables.

The residuals were also tested for serial correlation and then plotted against time.[7] This was done not

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[7]See footnotes 3 and 4, Chapter IV, pp. 47, 48.

to eliminate the serial correlation but rather to see if one of the variables used in this thesis could explain the serial correlation. For this test, the von Neumann Hart ratio was used and tested at the .05 level.[8]

In determining the lag during changing prices, a dummy variable was used. The dummy variables used were designated as X_{12}, X_{13}, and X_{14}. In this approach to determine the farm to retail lag, a retail price was used as the dependent variable, farm price, farm quantity of pork and beef were used as the independent variable along with the dummy variable. The dummy variable was defined as 0 or 1: 0 if the change of the independent variable from one observation (t-1) to the next observation (t) was positive and 1 if the change was negative or if there was no change. X_{12} was the change in the farm level price from one observationto the next, X_{13} was the change in the price of pork loin and X_{14} was the change in the price of butts. The general equation was as follows:

$$\text{Set } j^{th} \quad \begin{array}{ll} (P_{r_r})_t = (a + b_1 P_{f_p} + b_2 Q_{f_p} + b_3 Q_{f_b} + b_4 X_{12})_t & j.0 \\ \vdots & j.1 \\ \vdots & j.2 \\ (P_{r_r})_t = (a + b_1 P_{f_p} + b_2 Q_{f_p} + b_3 Q_{f_b} + b_4 X_{12})_{t-3} & j.3 \end{array}$$

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[8]When using various statistical tests, an α or probability level (P) is usually stated. P = .05 means that the obtained results have a 5% probability of occurring by chance alone.

where j = a particular set of equations in a particular series, and the number after the j = the number of weeks the independent variable are lagged for the equation.

For the wholesale to retail lag, the price of a specific wholesale cut was substituted for farm price of pork and the appropriate dummy variable used. The same procedure was followed to determine the farm to wholesale lag. Each lagged equation was calculated for the combined seven years period. These computations were made by electronic computer. As in the over-all lag, the various lagged equations were tested for significance by the F ratio test and the R^2 plotted against the lag for a graphic analysis of the lag.

Throughout this thesis, no tests of significance will be presented on the b_i coefficients as both inter-correlation and serial correlation exist in the equations. This is assumed not to invalidate the findings of this thesis, as it is not the purpose to obtain the true structural coefficients, but rather to determine whether there exists a time lag between price adjustments at various levels.

Inter-correlation is defined as correlation among the independent variables. Multicollinearity is an extreme case of inter-correlation where the correlation among independent variables is so high that their separate effects can't be measured. As the level of inter-correlation increases, the standard errors of the net regression coefficients increase and this leads to lower reliability for the individual regression constants. In some cases, when the inter-correlation between variables reaches a certain point, the "weaker" of the partial regression coefficients may under-go a sign change.[9]

Inter-correlation existed among the independent variables used in this thesis. The simple correlation (R) between farm price of pork (P_{f_p}) and farm quantity of pork (Q_{f_p}) was -.523; R between P_{f_p} and farm quantity of beef (Q_{f_b}) was +.106; and R between Q_{f_p} and Q_{f_b} was -.290. Because of this inter-correlation the S_{b_i} or standard errors of the net regression coefficients may become large.

Serial correlation was also present in the equations. This makes the usual test of significance for the coefficients invalid. Therefore, no test for significance was made on the coefficients, but the sign of each b_i was checked to see if it agreed with the expected results.

In determining what the signs of the b_i should be,

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[9]K. A. Fox and J. F. Cooney, Jr., "Effects on Inter-correlation upon Multiple Correlation and Regression Measures," USDA, AMS (Washington, 1954). (Mimeographed.)

one must consider how price changes of the factors of production will effect the final product price and the nature of product substitution.

Since hogs are the main factor of production in producing pork for consumption, when the price of hogs rises, the price of the final product must also rise as no other factor of production can be substituted for hogs. In this way, P_{f_p} is the price of the factor of production in producing wholesale cuts of pork, and one could consider price of the wholesale cuts the price of the factor of production in producing a final product of retail cuts. In this way, the b_i coefficient of a price independent variable should be positive.

In considering the supply of a factor, as the quantity of hogs increases, the price of pork should fall, i.e., quantity has an inverse effect on price. Also, as the quantity of beef increases, price of beef should decrease. Because pork and beef are good substitutes for each other, the price of pork should follow that of beef. One reason pork prices tend to follow beef prices is that pork is to some extent an inferior good to beef. Therefore, the price of beef has more effect on pork than the price of pork has on beef.[10]

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[10] Riley, p. 31.

From the above, one would expect the signs for the b_i coefficients for Q_{f_p} and Q_{f_b} to be negative. However, there was a simple correlation between Q_{f_p} and Q_{f_b} of -.290. This indicates that the two variables move in opposite directions and when Q_{f_b} is relatively high, Q_{f_p} is relatively lower. Since all the dependent variables are pork prices at some level, one could expect b_i of Q_{f_b} to take on the opposite sign from that of Q_{f_p}. The assumption behind this reasoning is that since Q_{f_p} has an inverse relationship with Q_{f_b}, Q_{f_b} will be measuring the effect of Q_{f_p} rather than itself. Q_{f_p} and Q_{f_b} do not necessarily have direct relationship to cause the difference in the two. They move in opposite directions because of the nature of production of the two species and their seasonal market patterns.[11]

No attempt will be made to ascertain why the signs of the b_i are as they are, as this is outside the main area of concern; however, if the signs differ from what is expected, a priori, they will be mentioned as areas for possible further study.

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[11]H. Breimyer and C. A. Kause, Charting the Seasonal Marketing for Meat Animals, USDA Agricultural Handbook No. 83 (Washington, 1955).

Margins

In investigating the various margins between prices, the lower level price at a one week lag (t-1) was subtracted from the higher level price at t. This defined the margin as the difference between the two prices at their assumed lagged relationship. The margins computed were farm to wholesale value, farm to specific wholesale cut price, farm to specific retail cut price and specific wholesale cut to specific retail cut price.

The various margins were fitted by regression equations first as a function of the lower level price used in computing that margin and second as a function of the upper level price of that margin. In both cases farm quantity of pork was included as an independent variable because the quantity of pork moving through the marketing channels influences margins.[12] The quantity of pork is to some extent measured by the price of pork but it was thought that as the independent price variable moves away from the farm level the relationship between price and the farm quantity of pork might become less apparent, therefore,

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[12] As the quantity of pork increases the margins increase. This is also reflected in farm price so that as quantity of pork increases, price decreases which gives an inverse relationship to farm price and margins.

making farm quantity a significant independent variable.

The above procedure was followed for the over-all lag, which used no dummy variable. Had the dummy variable approach proved to have significant value over the over-all lag approach a further investigation into margins would have been made.

CHAPTER IV

OVER-ALL LAG RESPONSE[1]

Farm to Wholesale Value

The first step in estimating the relationship between farm price and wholesale value was to plot them, along with the quantity of hogs, against time. From the graphic analysis it appeared that there was no lag between farm price and wholesale value. When considering the quantity of hogs on the market, there is the expected inverse relationship, price being high when quantity is low and vice versa. The relationship between farm price, wholesale value and farm quantity of hogs is shown in Figures 1-a to 1-g.

The non-lagged relationship between farm price and wholesale value was to be expected on a weekly average since wholesalers and packers have relatively good knowledge as to what prices can be paid and what must be received. Because of this, prices may be adjusted when the need arises. As previously stated in Chapter I, Stout and Feltner found no lagged relationship between farm price and wholesale

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[1]Over-all lag being defined as when there is no distinction made between rising and falling prices. It is the average lag.

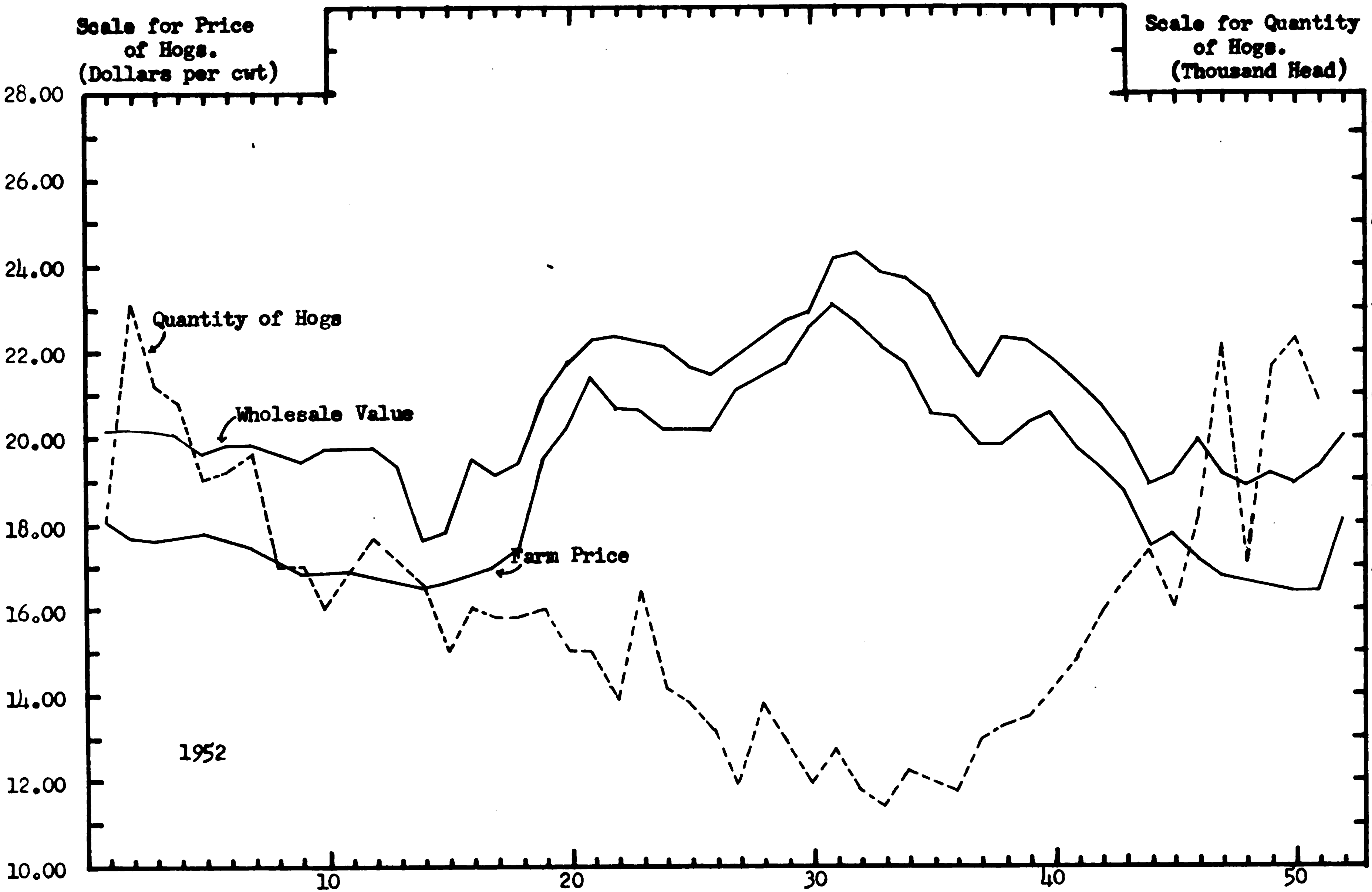

Figure 1-a. Average weekly movements of farm price, wholesale value and farm quantity of hogs, 1952.

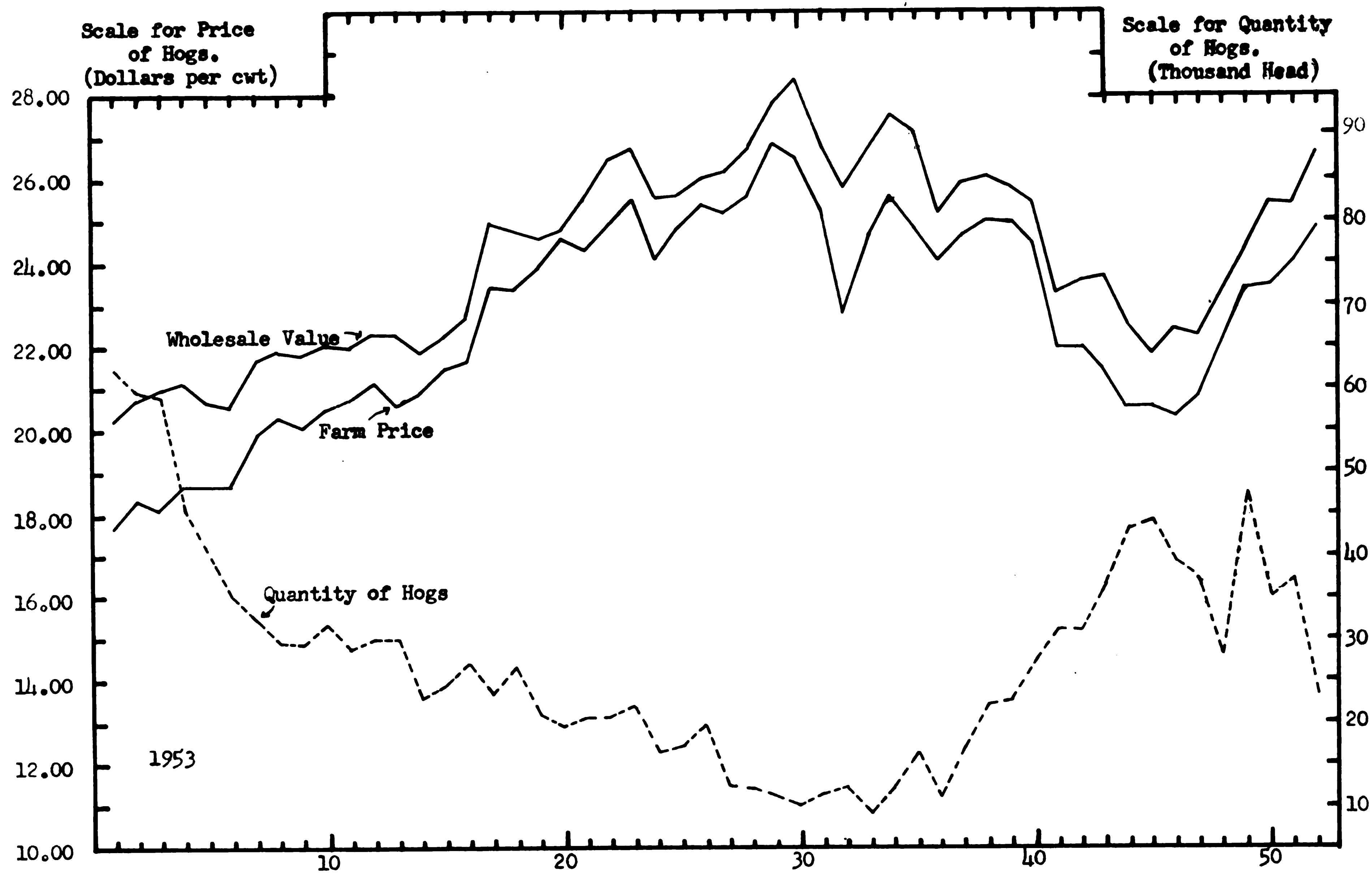

Figure 1-b. Average weekly movements of farm price, wholesale value and farm quantity of hogs, 1953.

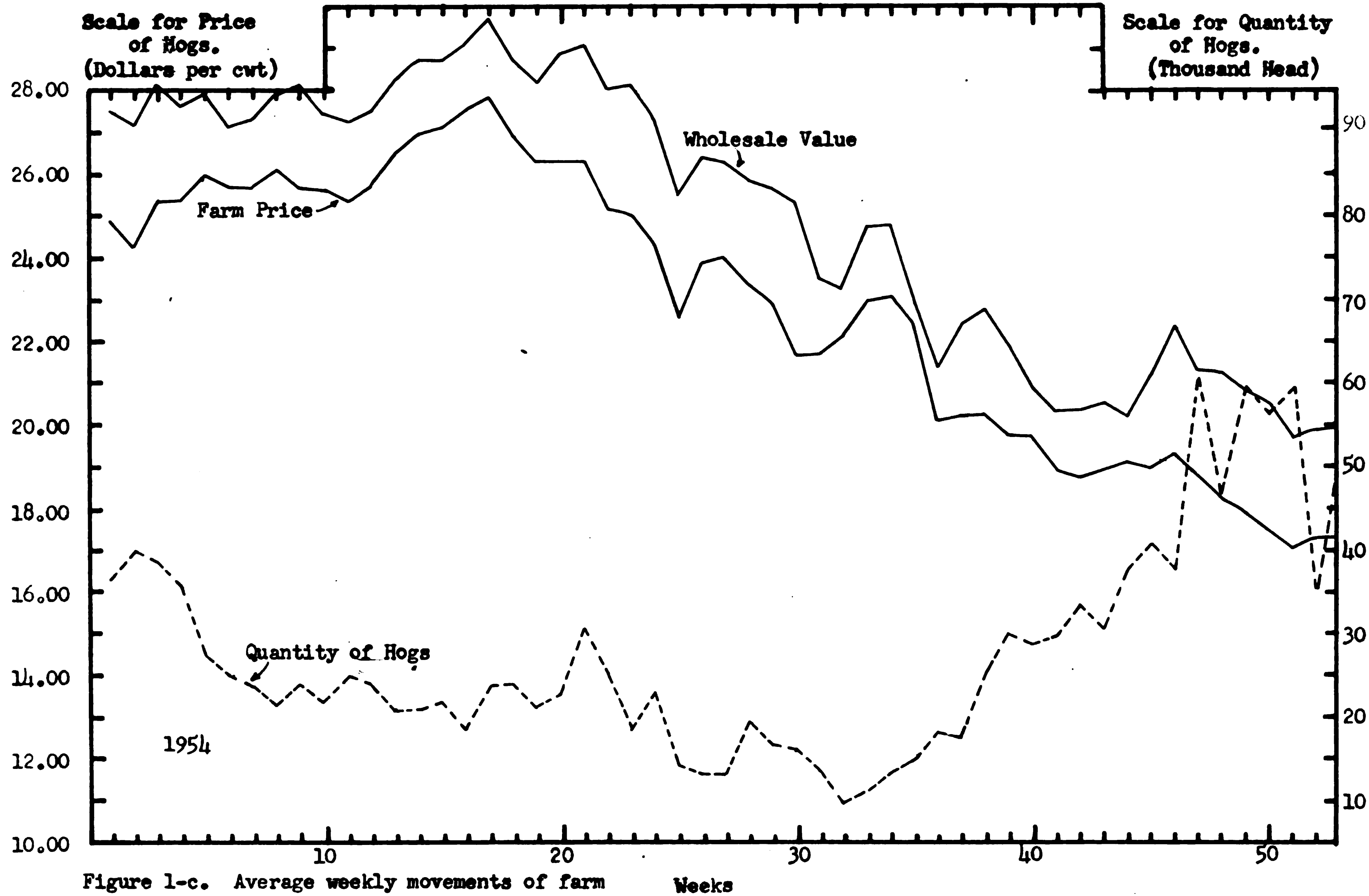

Figure 1-c. Average weekly movements of farm price, wholesale value and farm quantity of hogs, 1954.

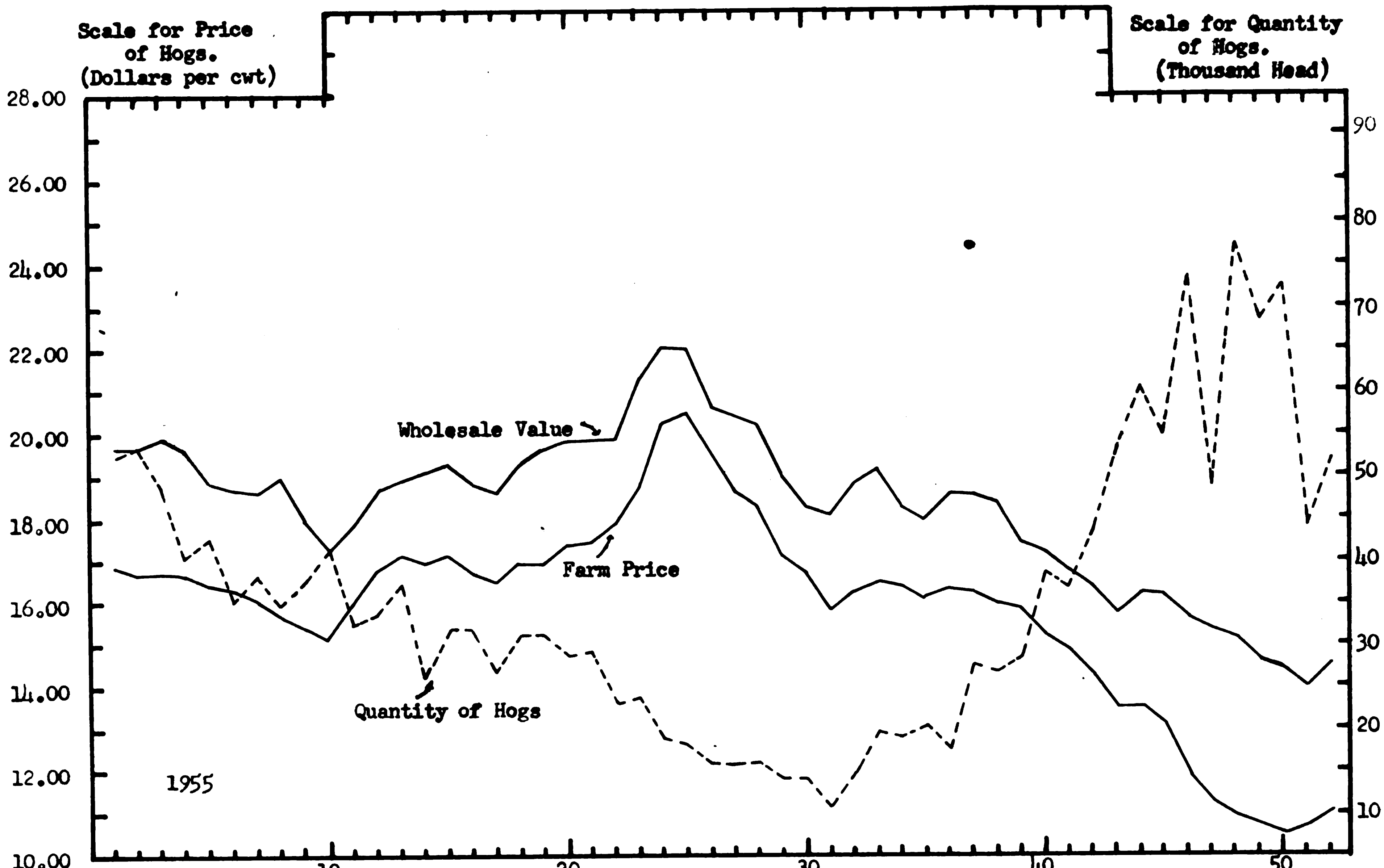

Figure 1-d. Average weekly movements of farm price, wholesale value and farm quantity of hogs, 1955.

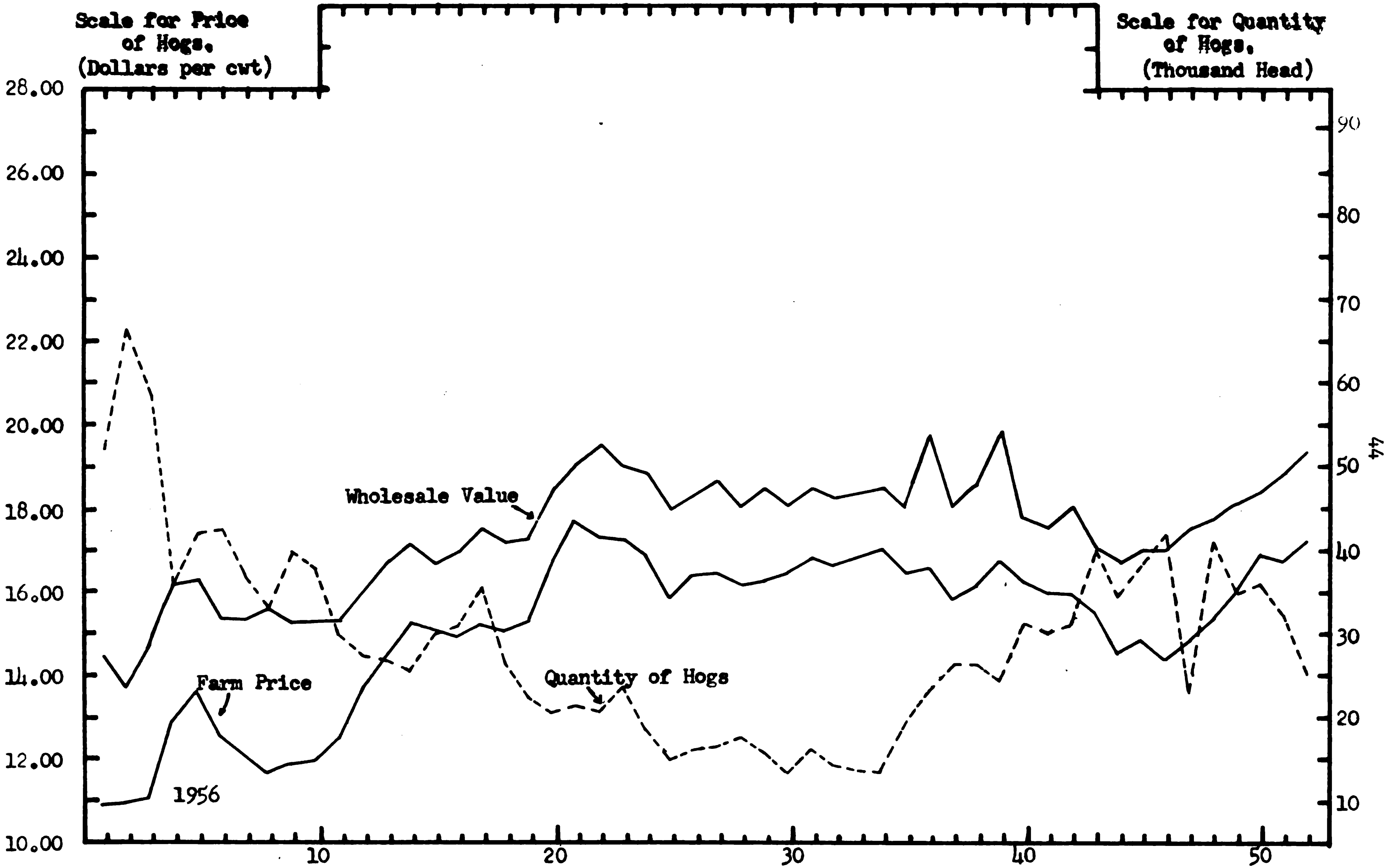

Figure 1-e. Average weekly movements of farm price, wholesale value and farm quantity of hogs, 1956.

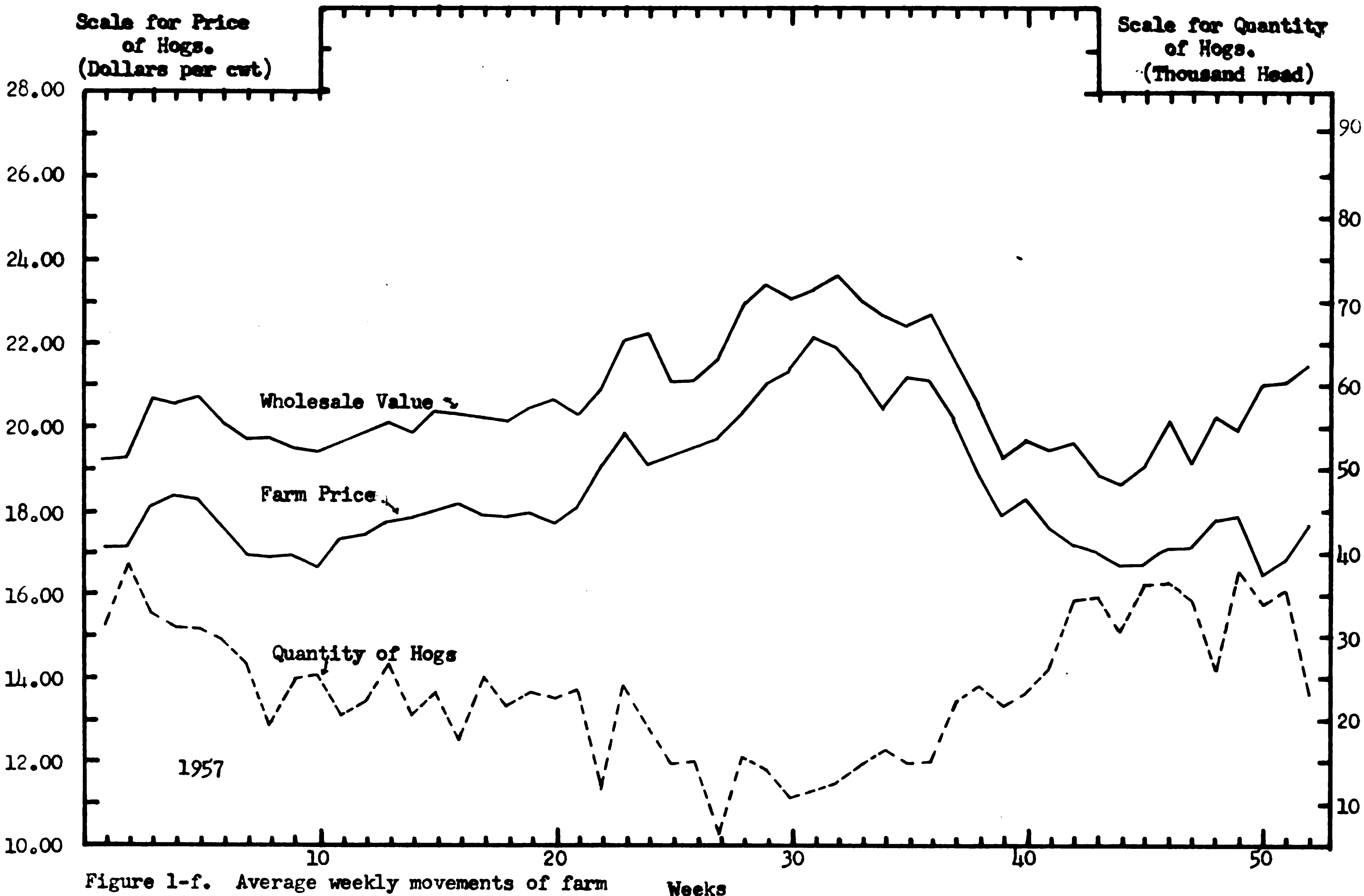

Figure 1-f. Average weekly movements of farm price, wholesale value and farm quantity of hogs, 1957.

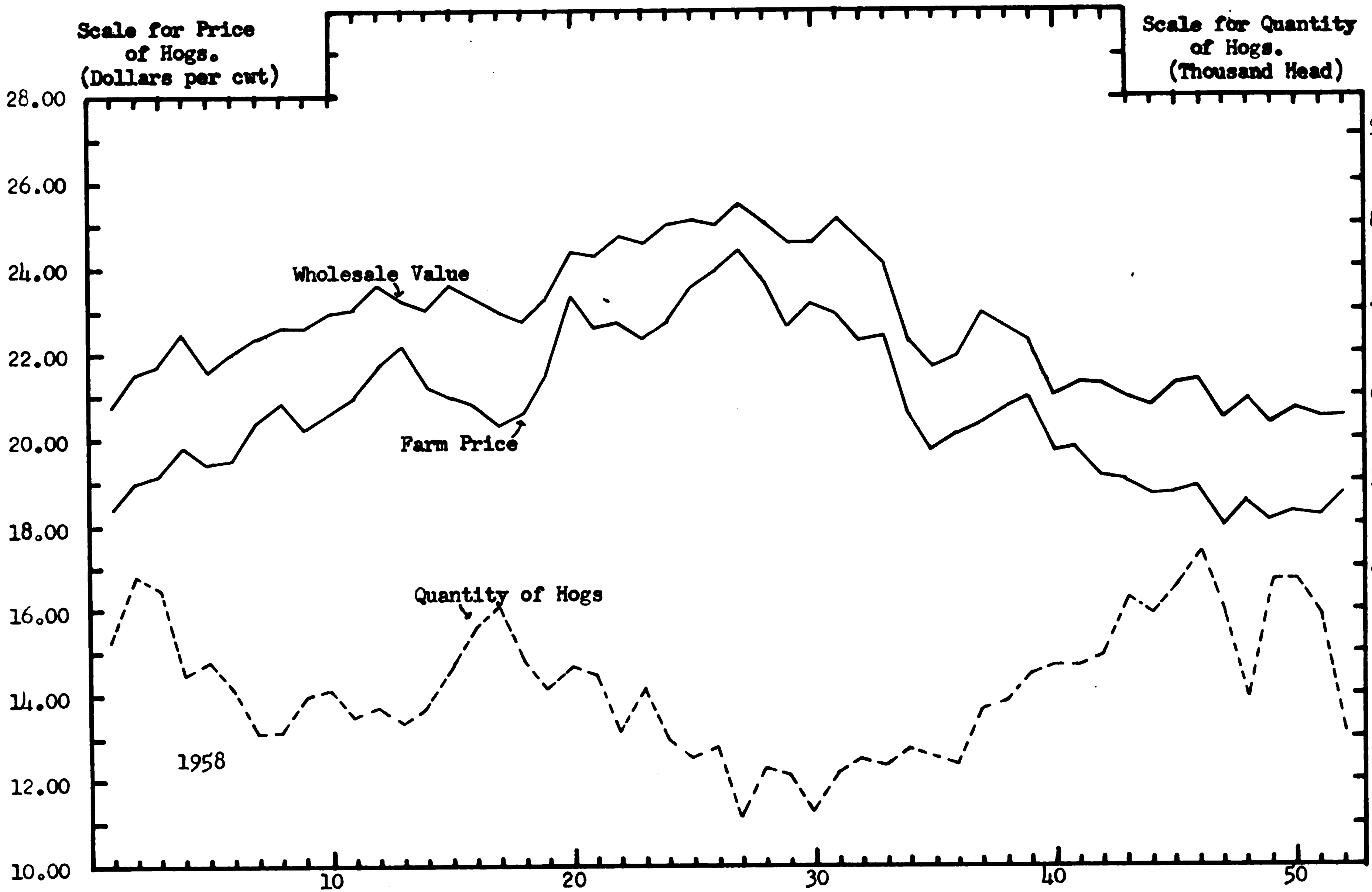

Figure 1-g. Average weekly movements of farm price, wholesale value and farm quantity of hogs, 1958.

value on a day to day basis.[2] This thesis tends to support their findings.

Since there appeared to be no lag in wholesale value response, only non-lagged equations were calculated. The first equation was

Eq. 1. $(P_{w_p})_t = (a + b_1 \; P_{f_p})_t$. 1.0

This equation was calculated for the combined period 1952 to 1958. The estimates of the coefficients are given in Table 4.1.

Table 4.1 Estimates of coefficients for equation 1.0.

Coefficient	Value	S_{b_i}	$t = \frac{b_{i-0}}{S_{b_i}}$	R^2
a	3.960	.158	25.02	.971
b	.902	.008	111.7	

The von Neumann Hart ratio test was used to determine if serial correlation was present.[3] In this test the Durbin Watson d' statistic was used as follows:

[2] Stout and Feltner, p. 217.

[3] Serial correlation is defined as the correlation of a series of observations and the same series lagged by one or more units of time.

$$\frac{\Sigma\ (\text{Residuals} - \text{Previous Residuals})^2}{\Sigma\ (\text{Residuals})^2} = d'$$

d' was then multiplied by $\frac{N}{N-1}$ to obtain the von Neumann Hart ratio $\frac{\delta^2}{s^2}$.[4]

$$\frac{N}{N-1} \cdot d' = \frac{\delta^2}{s^2} = K \quad \text{where K is the observed ratio.}$$

This test indicated that serial correlation was present. The observed K ratio was .6471. The critical value for the .05 level for K or K' is greater than unity therefore serial correlation is assumed to be present.[5] Because of this, the usual statistical tests of the coefficients were not applicable. However, the coefficients are both statistically unbiased and consistent and the

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[4]Dr. L V. Manderscheid, Agr. Econ. 831, class notes, Spring, 1962, Michigan State University.

$$d' = \frac{\sum_{k=2}^{N} (U_k - U_{k-1})^2}{\sum_{k=1}^{N} U_k^2}$$ Where $\sum_{k=2}^{N} (U_k - U_{k-1})^2$ is S(Res. - Prev. Res)^2 and where $\sum_{k=1}^{N} U_k^2$ is S(Res)^2.

[5]Mordecai Ezekiel and Karl Fox, Methods of Correlation and Regression Analysis (New York: John Wiley and Sons, Inc., 1961), p. 341. If the calculated value falls below the critical value of the table K value there is positive serial correlation and if above the table K' value, negative serial correlation is present.

estimate of the dependent variable is unbiased. It was assumed that serial correlation would not be of sufficient importance to invalidate the findings of the graphic and regression analysis indicating that there was no lag between farm price and wholesale value. Figure 2 presents the graphic illustration of the residuals from equation 1.0.

Farm to Wholesale Cut

The next step was to determine the lag between farm price and specific wholesale cut price. Again the various prices were plotted for a graphic analysis. This is shown in Figures 3-a to 3-g. By visual inspection of the peaks and valleys, it seems apparent that no lag exists between wholesale value and price of loin or butt. Since there was no lag between farm price and wholesale value, it would appear that there is no lag between farm price and price of a specific wholesale cut.

Because of the non-lagged relationship of farm price and wholesale price, it was decided that only one price (farm) would be used for the equations. The regression equations used were as follows:

Eq. 2. $$(P_{w_l}) = (a + b_1 P_{f_p}) \qquad (2.0)$$

Eq. 3. $$(P_{w_s}) = (a + b_1 P_{f_p}) \qquad (3.0)$$

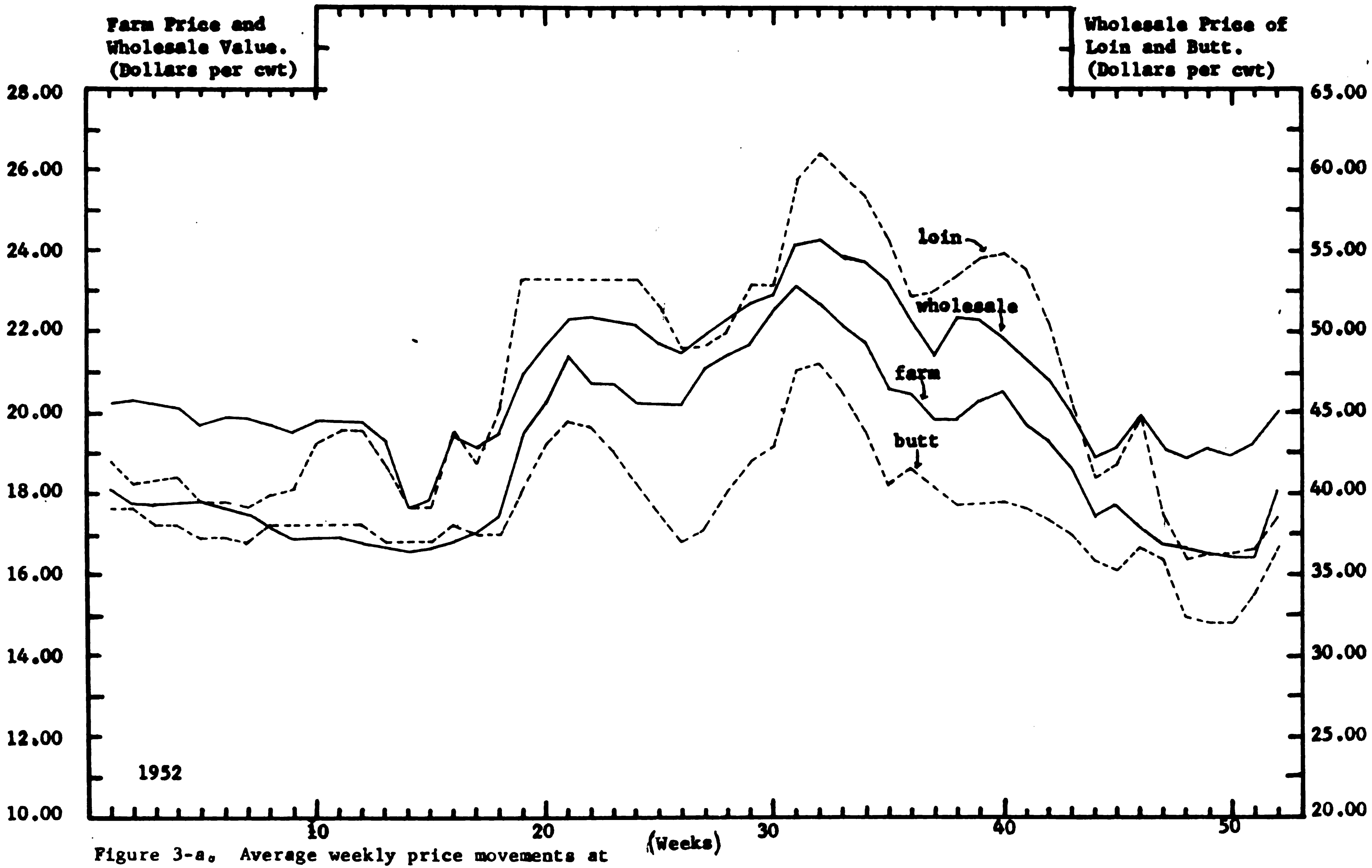

Figure 3-a. Average weekly price movements at farm and wholesale level, 1952.

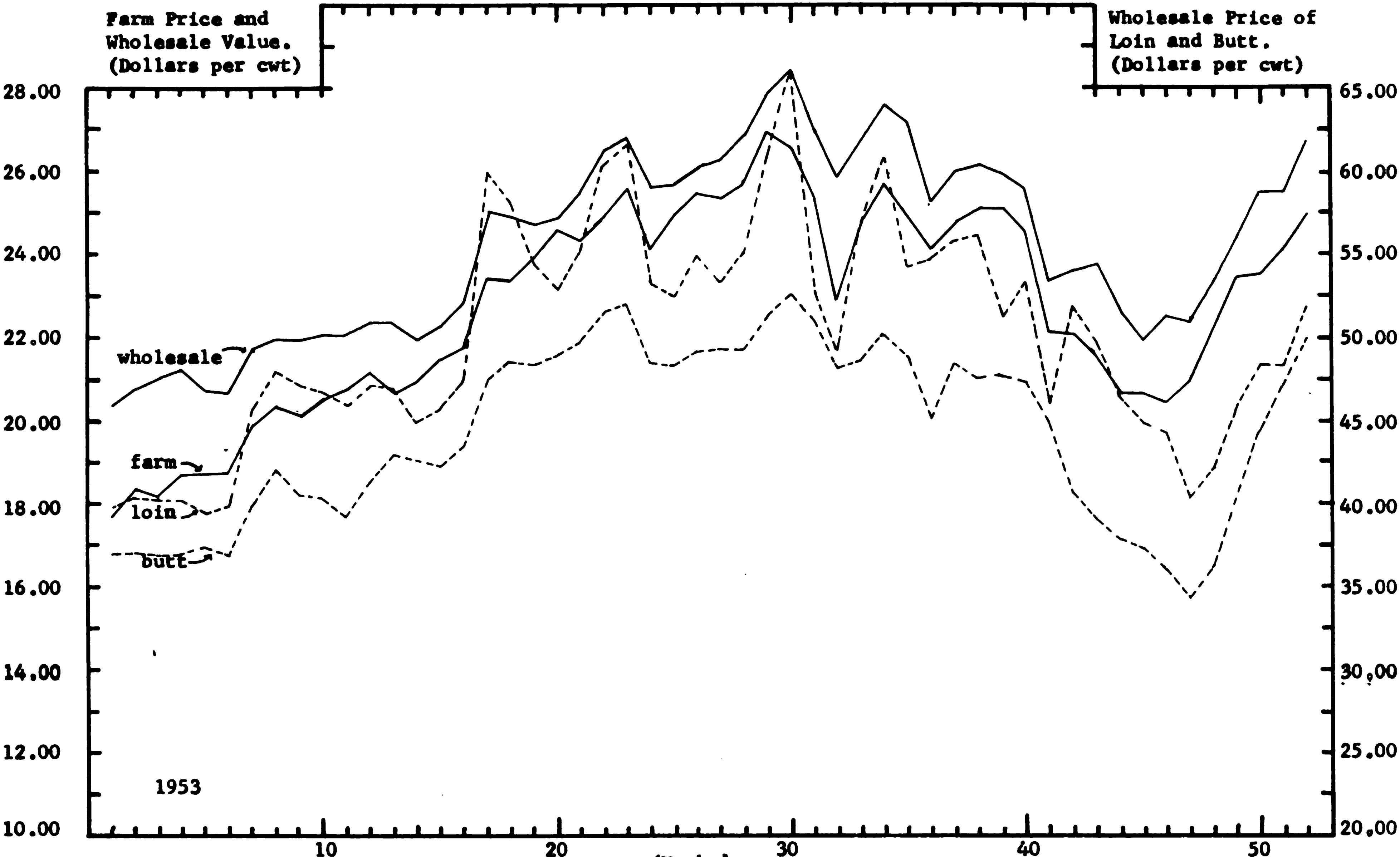

Figure 3-b. Average weekly price movements at farm and wholesale level., 1953.

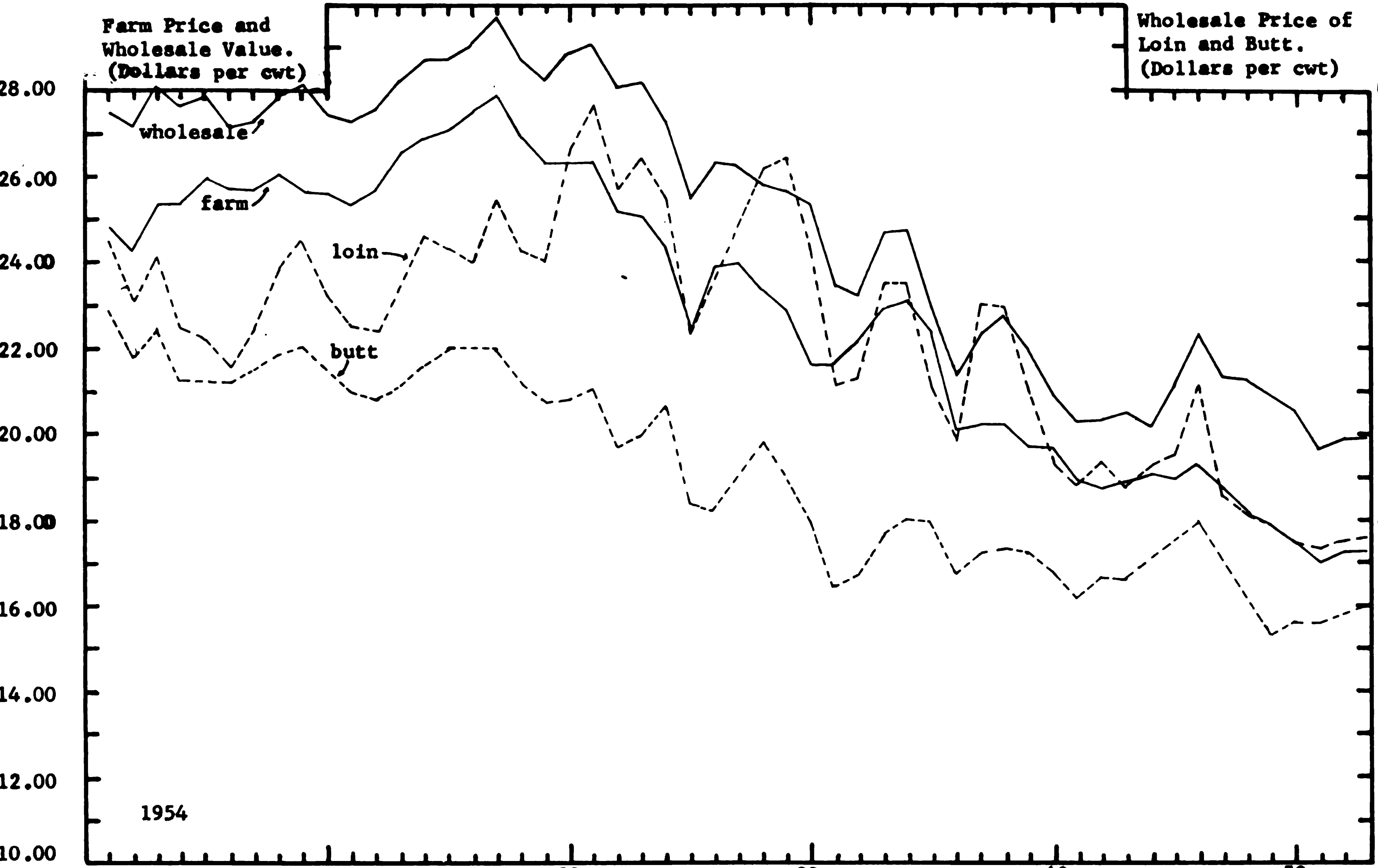

Figure 3-c. Average weekly price movements at farm and wholesale level, 1954.

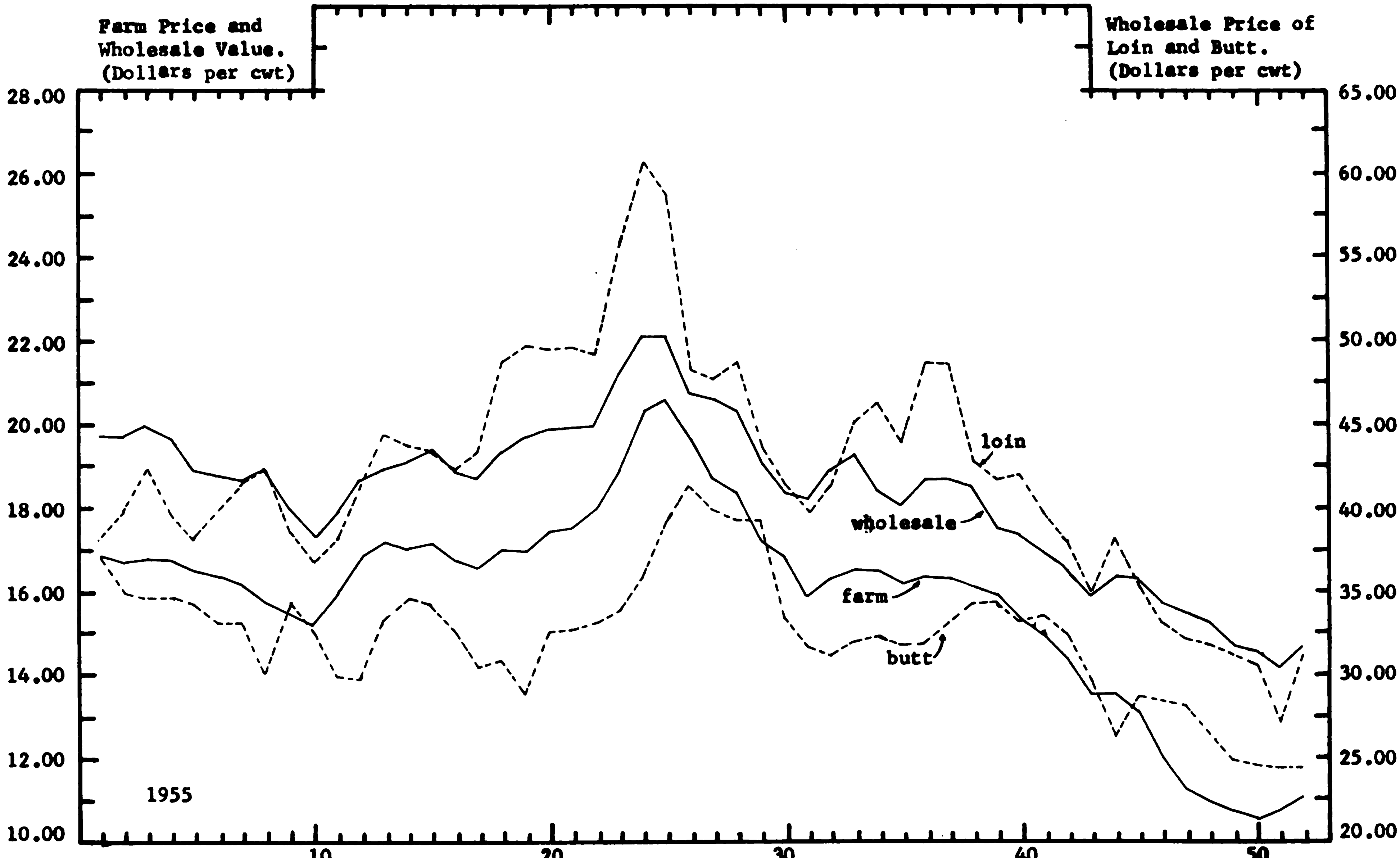

Figure 3-d. Average weekly price movements at farm and wholesale level, 1955.

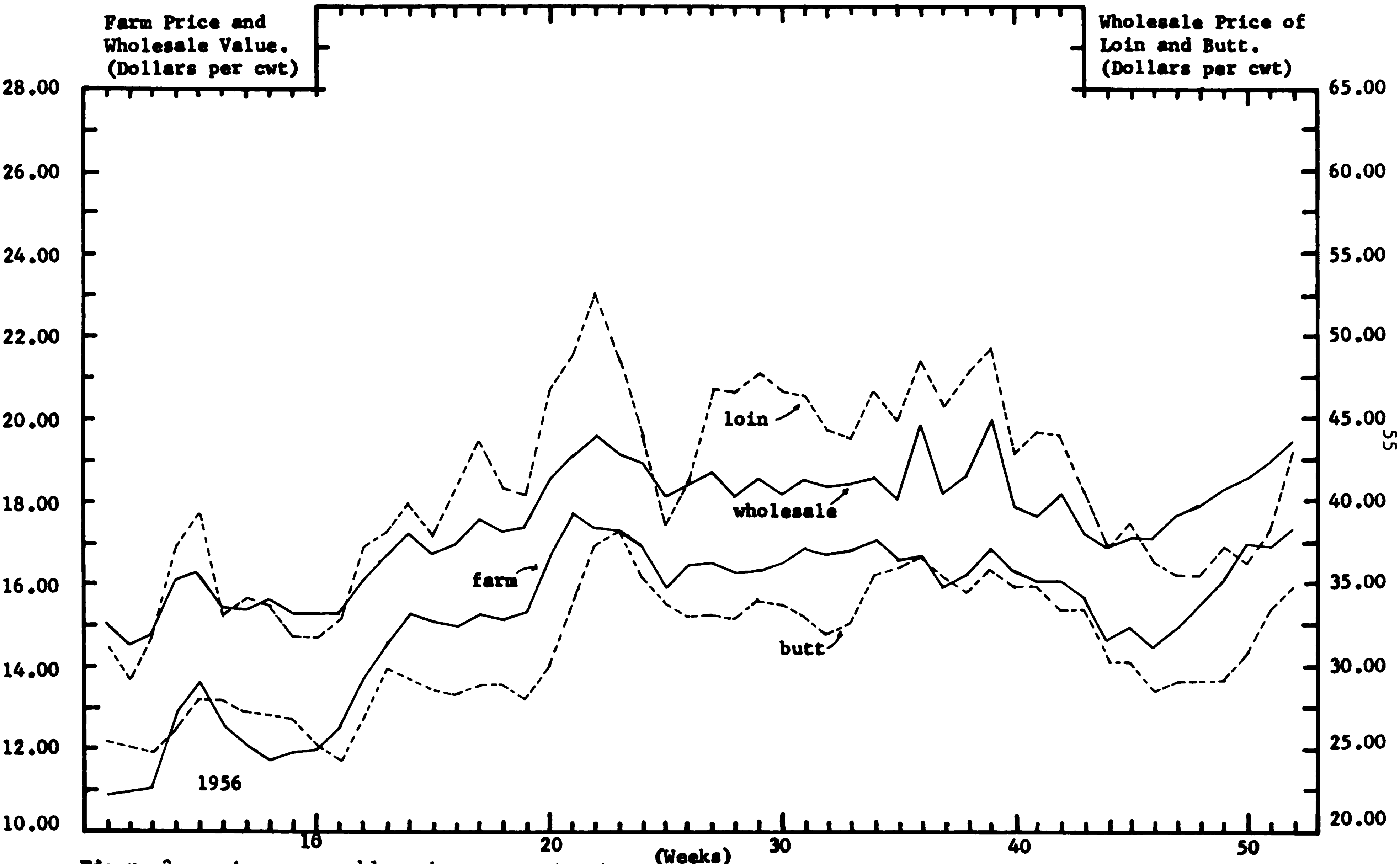

Figure 3-e. Average weekly price movements at farm and wholesale level, 1956.

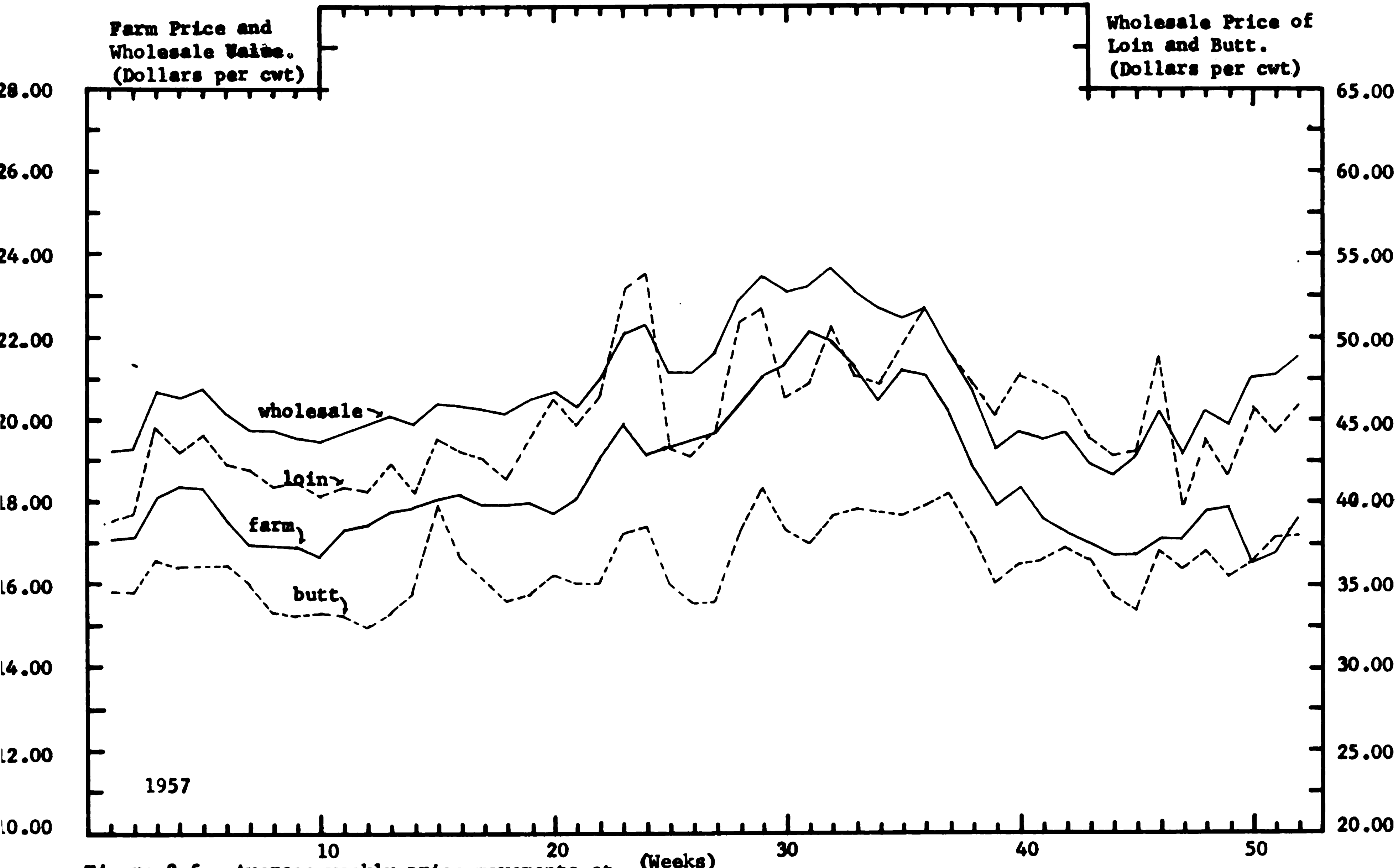

Figure 3-f. Average weekly price movements at farm and wholesale level., 1957.

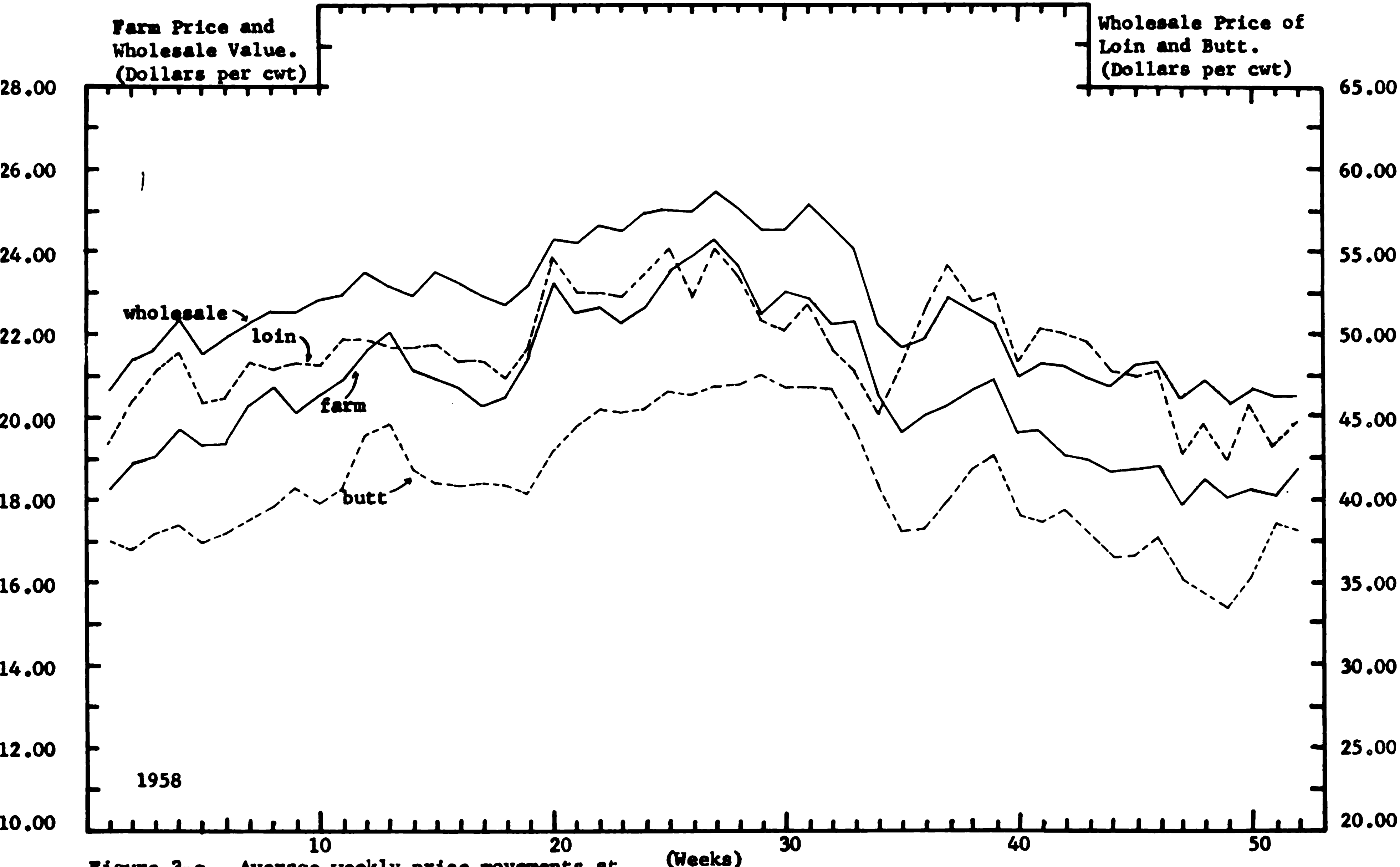

Figure 3-g. Average weekly price movements at farm and wholesale level, 1958.

These equations were calculated for the combined period 1952 to 1958. The results from these equations are presented in Table 4.2

Table 4.2 R^2 and $\hat{S}_u^2$* from equation sets 2 to 5 by lag period.

Set		0	1	2	3
2**	R^2	.720			
	$\hat{S}_u^2$	13.49			
3**	R^2	.888			
	$\hat{S}_u^2$	4.41			
4	R^2	.776	.754	.715	.675
	$\hat{S}_u^2$	10.85	11.94	13.86	15.82
5	R^2	.892	.884	.843	.790
	$\hat{S}_u^2$	4.31	4.61	6.28	8.44

*$\hat{S}_u^2 = \frac{\Sigma\ (Y - Y)^2}{d.f.}$ or the estimated variance of the U's (residuals).

**These equations were not lagged and therefore have only 0 or non-lagged equations.

The equations were then tested for serial correlation by the von Neumann Hart ratio test and were found to be serially correlated. The residuals were also plotted against time (see Figures 4-a to 4-c). Even though serial correlation is assumed not to invalidate the findings for

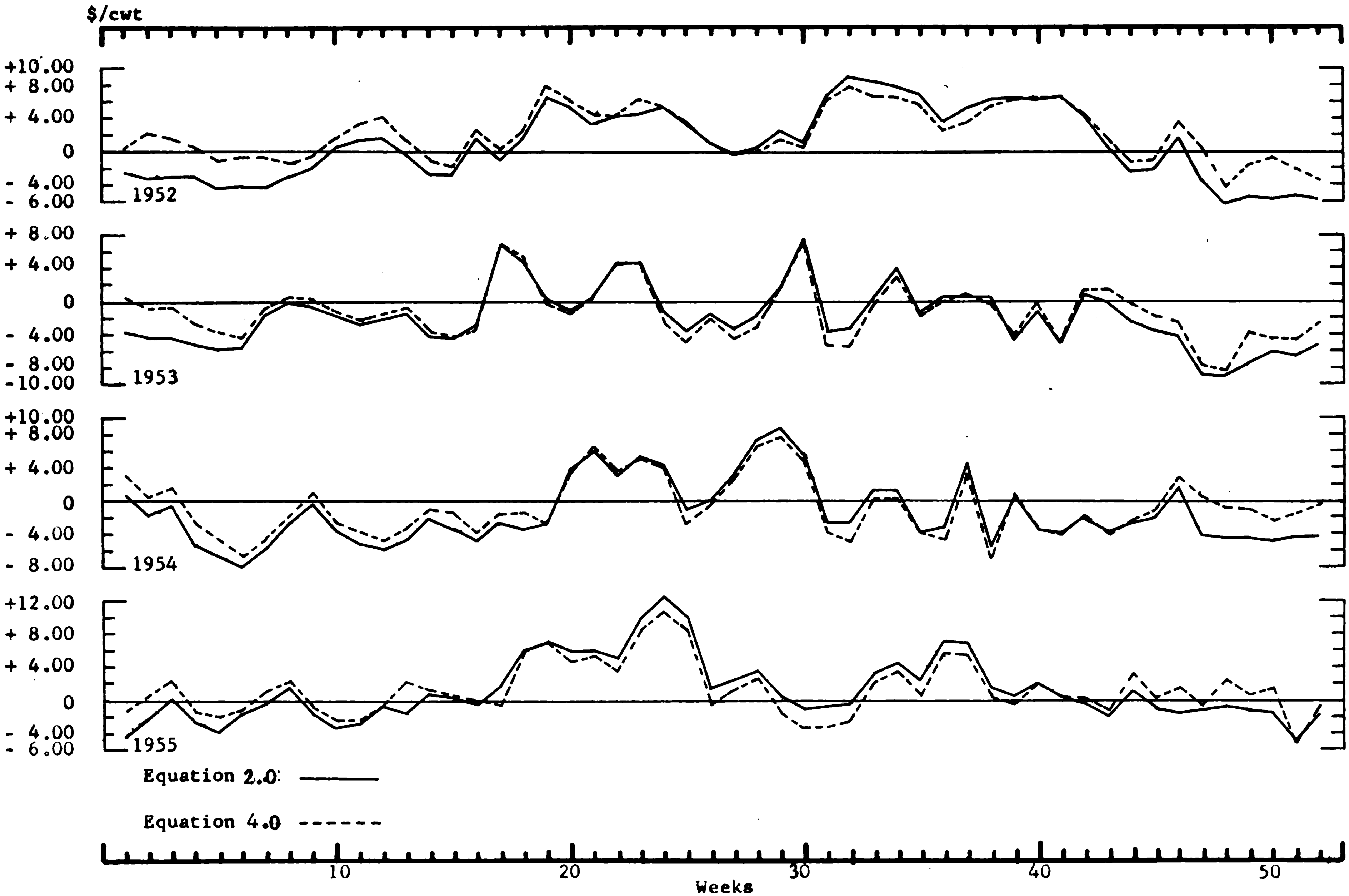

Figure 4-a. Residuals from equations 2.0 and 4.0, 1952 to 1955.

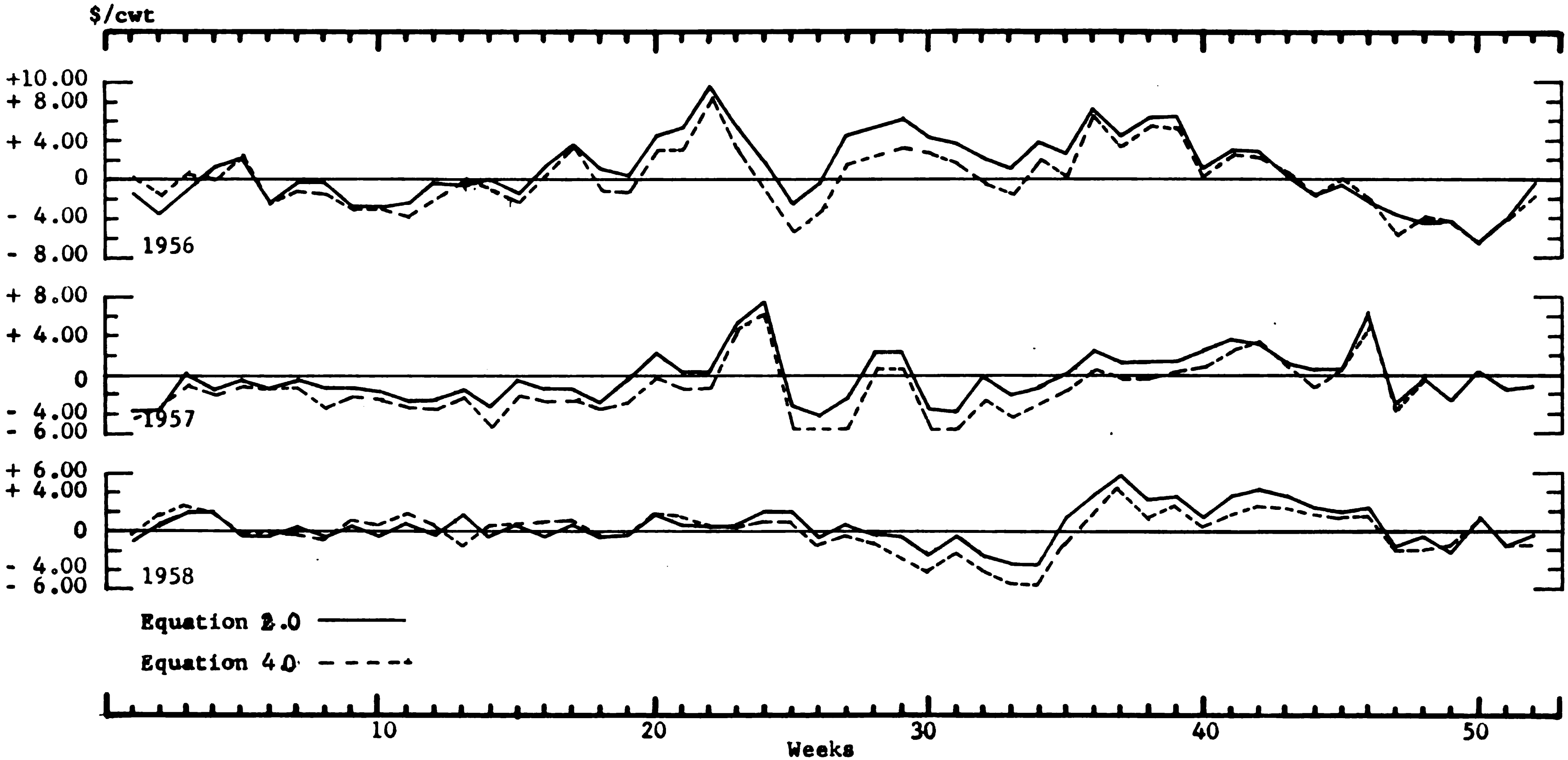

Figure 4-b. Residuals from equations 2.0 and 4.0, 1956 to 1958.

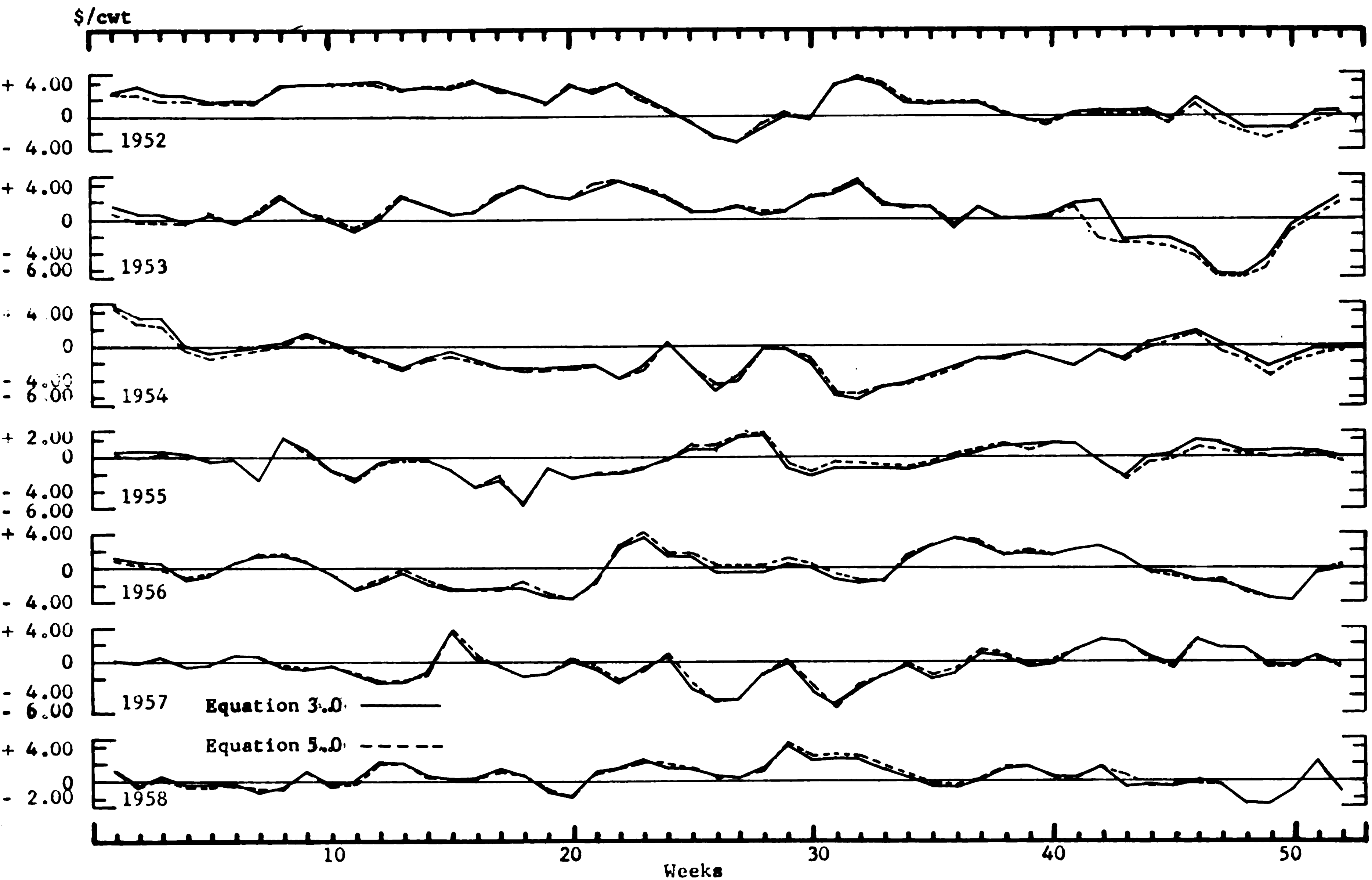

Figure 4-c. Residuals from equations 3.0 and 5.0, 1952 to 1958.

this thesis, it was thought that a more complete model could possibly return more significant results. The equations were then recalculated with the additional variables of farm quantities of pork and beef being added. The equations then became

Set 4

$$(P_{w_1})_t = (a + b_1 P_{f_p} + b_2 Q_{f_p} + b_3 Q_{f_b})_t \qquad (4.0)$$

$$. \quad . \quad . \quad . \quad . \qquad (4.1)$$

$$. \quad . \quad . \quad . \quad . \qquad (4.2)$$

$$(P_{w_1})_t = (a + b_1 P_{f_p} + b_2 Q_{f_p} + b_3 Q_{f_b})_{t-3} \qquad (4.3)$$

Set 5

$$(P_{w_s})_t = (a + b_1 P_{f_p} + b_2 Q_{f_p} + b_3 Q_{f_b})_t \qquad (5.0)$$

$$. \quad . \quad . \quad . \quad . \qquad (5.1)$$

$$. \quad . \quad . \quad . \quad . \qquad (5.2)$$

$$(P_{w_s})_t = (a + b_1 P_{f_p} + b_2 Q_{f_p} + b_3 Q_{f_b})_{t-3} \qquad (5.3)$$

These equations were calculated in the same manner as equations 2.0 and 3.0. The resulting R^2 (coefficient of determination) and $\hat{S}_u^2$ (estimated variance of the residuals) are presented in Table 4.2.

The equations 2.0, 3.0, 4.0 and 5.0 were tested for serial correlations and the residuals plotted against time (see Figures 4-a to 4-c) to determine the effects of the two additional variables, Q_{f_p} and Q_{f_b}, upon the serial correlation. In both cases, R^2 was increased but the serial correlation decreased by such a relatively small amount that the two additional variables proved to have no significant effect upon the serial correlation. Since there appeared to be no lag, only equations 2.0, 3.0, 4.0 and 5.0 were considered when determining the serial correlation.

The F ratio test was applied to the different sets of equations having the same dependent variables; the comparison being between equations 2.0 and 4.0, and 3.0 and 5.0. Since the test was to see if the $\hat{S}_u^2$ was reduced by a significant amount by adding the variables Q_{f_p} and Q_{f_b}. $\hat{S}_u^2$ from equations 4.0 and 5.0 were used as the denominator in computing the F ratio, as these equations had the smallest $\hat{S}_u^2$.

The F ratio test was made in the following manner:

$$\frac{\hat{S}^2_{u_{2.0}}}{\hat{S}^2_{u_{4.0}}} = F_{2.0-4.0} > \text{critical value}^6$$

$$(1.24) > 1.20$$

$$\frac{\hat{S}^2_{u_{3.0}}}{\hat{S}^2_{u_{5.0}}} = F_{3.0-5.0} < \text{critical value}$$

$$1.02 < 1.20$$

where the subscript number to the $\hat{S}_u^2$ designates the equation associated with that particular $\hat{S}_u^2$

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[6]George W. Snedecor, Statistical Methods (4th Ed.; Iowa State Press, 1946), p. 224, Table 10.7. The critical value was determined by linear interpolation using 350 degrees of freedom in both the numerator and the denominator.

and the subscript to the F ratio designates the equations used in computing the F ratio with the equation used as the denominator coming last in the subscript.

Since the observed F ratio, $F_{2.0-4.0}$, exceeded the critical value and F ratio $F_{3.0-5.0}$ did not, it was concluded that the two variables Q_{f_b} and Q_{f_b} added a significant amount to equation 4.0 but not to equation 5.0.

Cross checks could have been made to determine which dependent variable was more fully explained by the independent variables but by inspection one could see that the equations with P_{w_s} (wholesale price of butt) had a much smaller $\hat{S}_u^2$ than the equations with P_{w_l} (wholesale price of loin) as the dependent variable.

This difference may be due to the fact that loin prices tend to be more stable than butt prices. Butt prices follow more closely to the fluctuations of farm price. This is substantiated by the simple correlation of P_{f_p} and the two wholesale prices. R for P_{f_p} and P_{w_l} = + .849 and R for P_{f_p} and P_{w_s} = + .924.

While graphic analysis might have been sufficient for determining the lags, lagged equations were calculated for a mathematical proof. It was expected, a priori, that there would be no lag between farm and wholesale level. Table 4.2 shows that R^2 was reduced as the independent variables were lagged further back in time.

F ratio tests were made on the equations in each set and since the equation having no lag had the smallest $\hat{S}_u^2$ it was used as the demonimator in computing the F ratio. The F ratio tests for set 4 were made in the following manner:

$$\frac{\hat{S}^2_{u_{4.1}}}{\hat{S}^2_{u_{4.0}}} = F_{4.1-4.0} < \text{critical value}$$
$$(1.10) \qquad (1.20)$$

$$\frac{\hat{S}^2_{u_{4.2}}}{\hat{S}^2_{u_{4.0}}} = F^*_{4.2-4.0} > \text{critical value}$$
$$(1.27) \qquad (1.20)$$

$$\frac{\hat{S}^2_{u_{4.3}}}{\hat{S}^2_{u_{4.0}}} = F^*_{4.3-4.0} > \text{critical value}$$
$$(1.46) \qquad (1.20)$$

*Significant at the .05 level.

The F ratio tests for set 5 were made in the following manner:

$$\frac{\hat{S}^2_{u_{5.1}}}{\hat{S}^2_{u_{5.0}}} = F_{5.1-5.0} < \text{critical value}$$
$$(1.06) \qquad (1.20)$$

$$\frac{\hat{S}^2_{u_{5.2}}}{\hat{S}^2_{u_{5.0}}} = F^*_{5.2-5.0} > \text{critical value}$$

$$(1.45) \qquad (1.20)$$

$$\frac{\hat{S}^2_{u_{5.3}}}{\hat{S}^2_{u_{5.0}}} = F^*_{5.3-5.0} > \text{critical value}$$

$$(1.95) \qquad (1.20)$$

*Significant at the .05 level.

In testing both sets of equations $F_{4.1-4.0}$ and $F_{5.1-5.0}$ did not prove to be significant. From these tests it can be assumed that there is no lag of as much as one week but a lag in the terms of days could be possible. In respect to lags in the terms of weekly data, it can be assumed that there is no lag between farm and wholesale level.

In checking the signs of the b coefficients, the expected signs were found for set 4; P_{f_p} or b_1 was positive, Q_{f_p} or b_2 was negative and Q_{f_b} or b_3 was positive. For set 5 the b_1 coefficient had the expected sign but b_2 and b_3 had reverse signs with b_2 being positive and b_3 being negative. Under the relationship assumed in Chapter IV, the sign change of the b_3 coefficient was due to the inter-correlation of Q_{f_p} and Q_{f_b}. Because of this the b_3

coefficient of Q_{f_b} is not measuring Q_{f_b} but rather the effect of Q_{f_p}. No attempt was made to determine the reason for the sign change on the b_2 coefficient of Q_{f_p}.

By graphic analysis alone it was possible to determine that there was no apparent lagged relationship between farm price and the price of the selected wholesale cuts on an over-all basis. The mathematical calculations were included for the purpose of significance testing. These tests tended to support the graphic analysis. However, this is not to say that no lagged relationship exists when considered on the basis of a changing price structure. This particular aspect will be taken up in a later chapter.

Farm to Retail

In determining the farm to retail lag, the first step was to plot the various prices by weeks (see Figures 6-a to 6-g). The next step was to formulate a series of equations, each being lagged one observation period behind the previous one. The equation series using P_{r_c} (retail price of pork chops) as a dependent variable is as follows:

Set 6.

$$(P_{r_c})_t = (a + b_1 P_{f_p} + b_2 Q_{f_p} + b_3 Q_{f_b})_t \qquad (6.0)$$

$$. \quad . \quad . \quad . \quad . \qquad (6.1)$$

$$. \quad . \quad . \quad . \quad . \qquad (6.2)$$

$$(P_{r_c})_t = (a + b_1 P_{f_p} + b_2 Q_{f_p} + b_3 Q_{f_b})_{t-3}. \qquad (6.3)$$

A similar series was formulated using P_{r_r} (retail price of pork roast) as the dependent variable. It is as follows:

$$(P_{r_r})_t = (a + b_1 P_{f_p} + b_2 Q_{f_p} + b_3 Q_{f_b})_t \qquad (7.0)$$

Set 7.

$$\cdot \quad \cdot \quad \cdot \quad \cdot \quad \cdot \qquad (7.1)$$

$$\cdot \quad \cdot \quad \cdot \quad \cdot \quad \cdot \qquad (7.2)$$

$$(P_{r_r})_t = (a + b_1 P_{f_p} + b_2 Q_{f_p} + b_3 Q_{f_b})_{t-3}. \qquad (7.3)$$

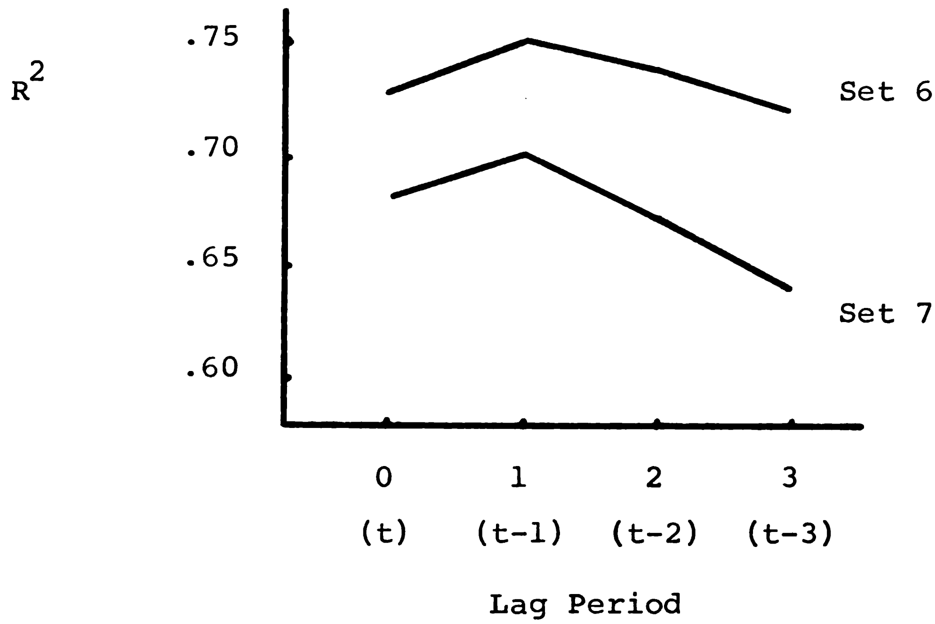
The above equations were calculated for the combined period 1952 to 1958 and the R^2 and $\hat{S}_u^2$ appear in Table 4.3.

Table 4.3. R^2 and $\hat{S}_u^2$ from equation sets 6 and 7 by lag periods.

Set		0	1	2	3
6	R^2	.729	.753	.737	.721
	$\hat{S}_u^2$	.106	.096	.099	.108
7	R^2	.683	.699	.673	.643
	$\hat{S}_u^2$	.153	.146	.159	.174

The R^2 from the combined data were plotted by lag period (see Figure 5) and from this there appears to be a lag of one week in retail prices.

Figure 5. Graphic illustrations of the coefficientsof determination obtained from equation sets 6 and 7, by lag periods.



The next step was to determine if the differences in the various lags were statistically significant. Since a lag of one week (eq. 1 or t-1) appeared to be the correct lag in that it had the highest R^2, the other lag periods were compared to the equation that was lagged one week. The F ratiosused to compare the various equations were made in the following manner:

$$\frac{\hat{S}^2_{u_{6.0}}}{\hat{S}^2_{u_{6.1}}} = F_{6.0-6.1} < \text{critical value}$$

(1.10) (1.20)

$$\frac{\hat{S}^2_{u_{6.2}}}{\hat{S}^2_{u_{6.1}}} = F_{6.2-6.1} < \text{critical value}$$
$$(1.03) \qquad (1.20)$$

Set 6.

$$\frac{\hat{S}^2_{u_{6.3}}}{\hat{S}^2_{u_{6.1}}} = F_{6.3-6.1} < \text{critical value}$$
$$(1.12) \qquad (1.20)$$

$$\frac{\hat{S}^2_{u_{7.0}}}{\hat{S}^2_{u_{7.1}}} = F_{7.0-7.1} < \text{critical value}$$
$$(1.04) \qquad (1.20)$$

Set 7

$$\frac{\hat{S}^2_{u_{7.2}}}{\hat{S}^2_{u_{7.1}}} = F_{7.2-7.1} < \text{critical value}$$
$$(1.08) \qquad (1.20)$$

$$\frac{\hat{S}^2_{u_{7.3}}}{\hat{S}^2_{u_{7.1}}} = F_{7.2-7.1} < \text{critical value}$$
$$(1.19) \qquad (1.20)$$

None of the observed F ratios were significant at the .05 level; however, $F_{7.3-7.1}$ very closely approached significance. In both equation sets R^2 was largest when the independent variables were lagged one week. The differences did not prove statistically significant, but in view of the peaks and valleys of the price movements when the prices were plotted against time (see Figures 6-a to 6-g) it is assumed that a lag of one week exists between farm and retail price.

In checking the signs of the b_i coefficients, the expected signs were present for the b_i values for set 6. In set 7 the signs associated with the b_i values for equations 7.2 and 7.3 were as expected. This was not true for the b_i values for Q_{f_p} and Q_{f_b} in equations 7.0 and 7.1 as both signs were positive. This is in opposition to the assumption that the sign of the b_i for Q_{f_b} would be opposite to the sign for the b_i for Q_{f_p}. It was noted that the two b_i values for Q_{f_p} and Q_{f_b} had unexpected signs when P_{w_s} was the dependent variable in the farm-wholesale lag. In this series, pork roast has unexpected signs on the b_i values of the two quantity variables for no lag and one of one week. As before, the reason for this situation was not determined. It is an area that should receive further consideration.

Wholesale to Retail

The prices of the specific cuts at the various levels were plotted against time; by visual inspection of the peaks and valleys, there appeared to be a lag of one week from wholesale to retail level. (See Figures 6-a to 6-g.)

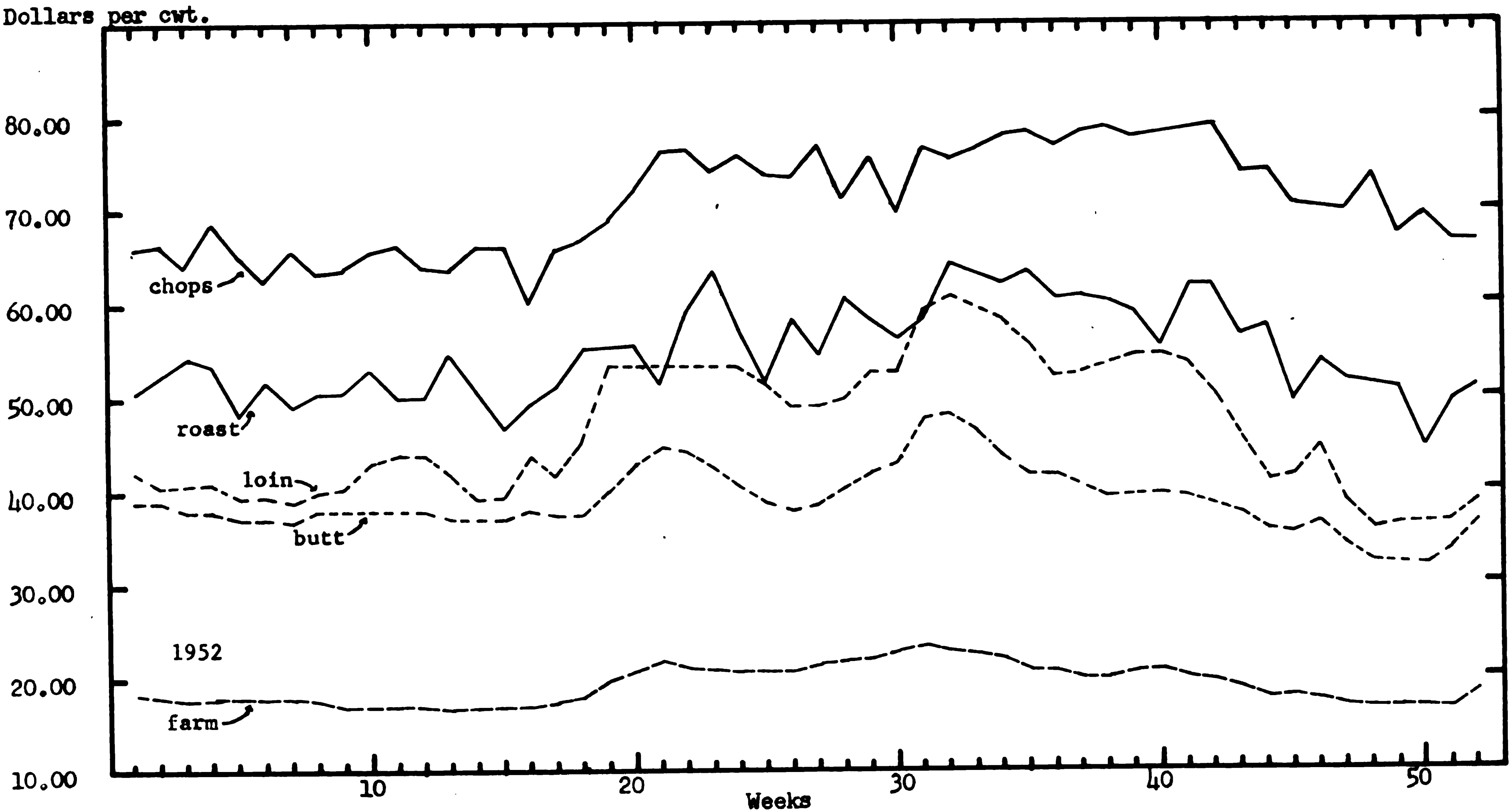


Figure 6-a, Average weekly price movements at retail, wholesale and farm level, 1952.

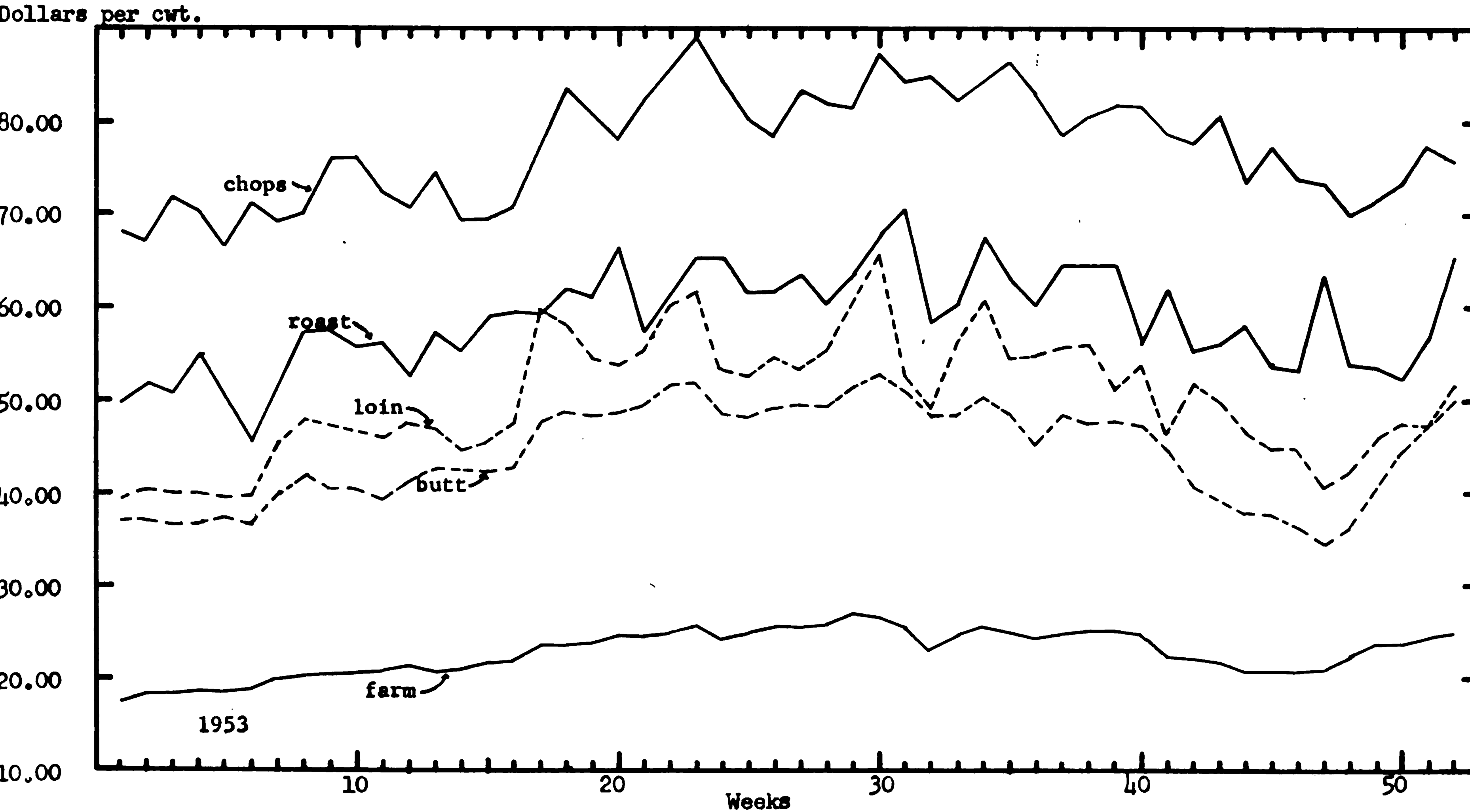


Figure 6-b. Average weekly price movements at retail, wholesale and farm level, 1953.

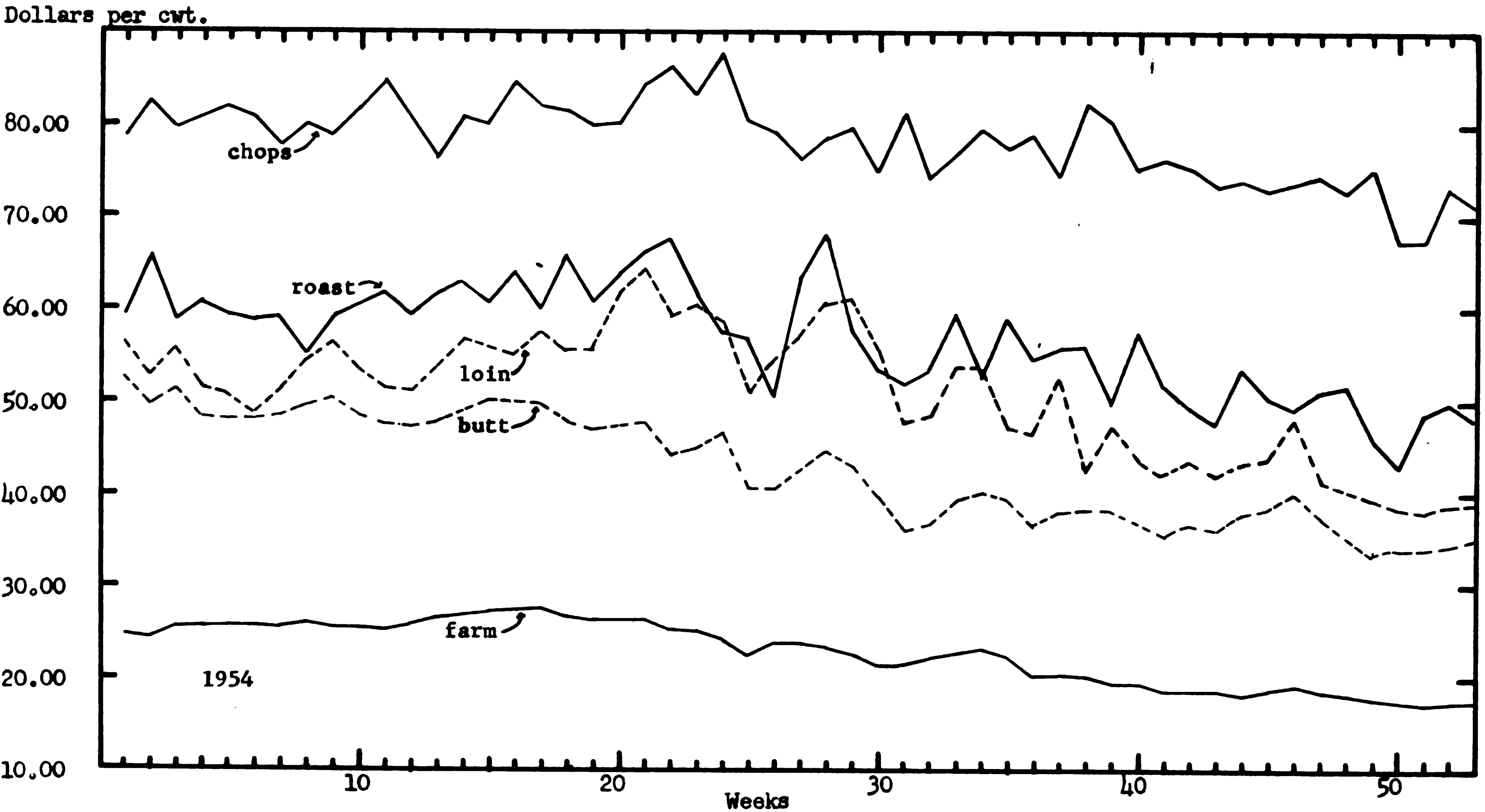


Figure 6-c. Average weekly price movements at retail, wholesale and farm level, 1954.

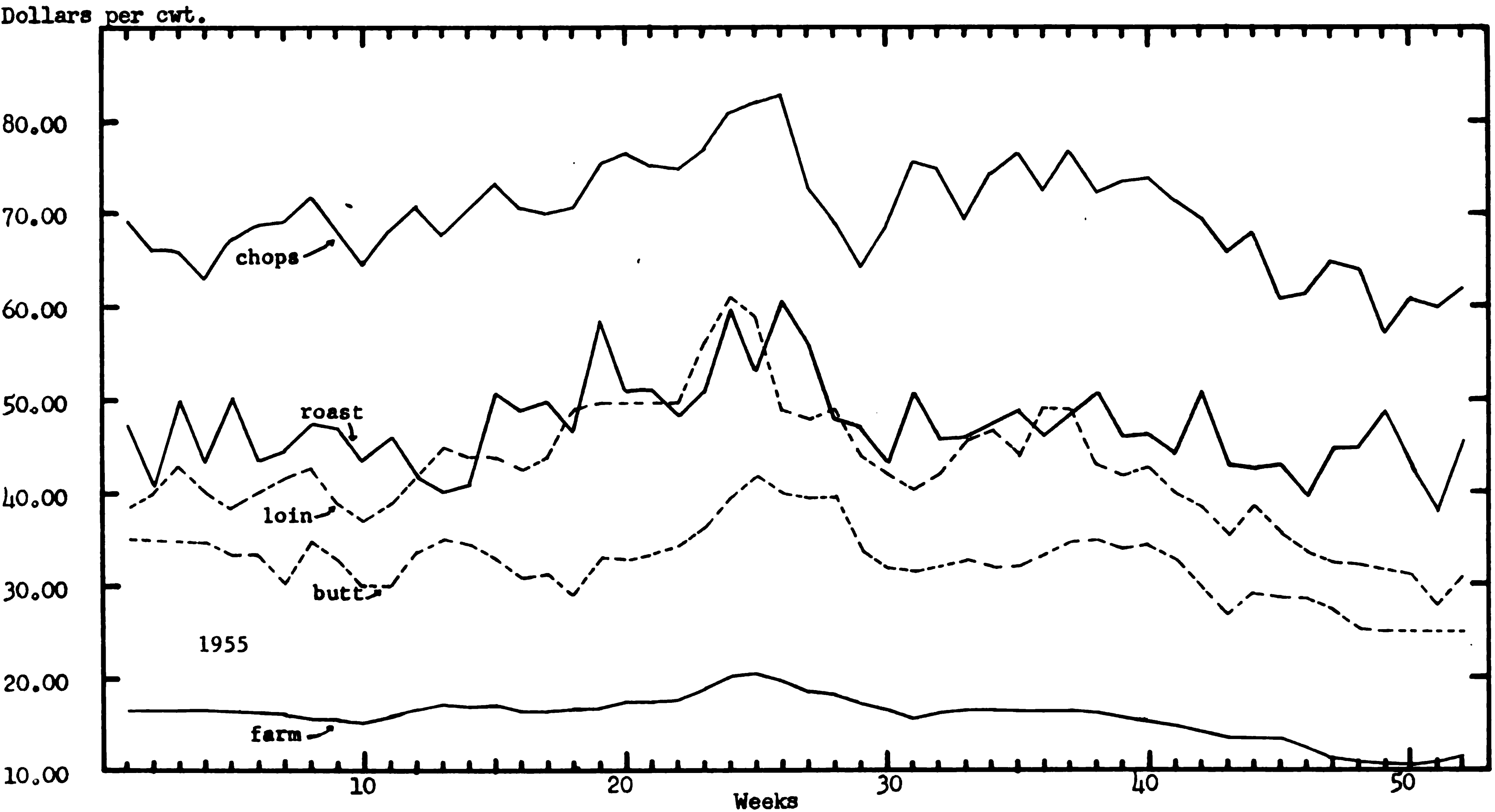


Figure 6-d. Average weekly price movements at retail, wholesale and farm level, 1955.

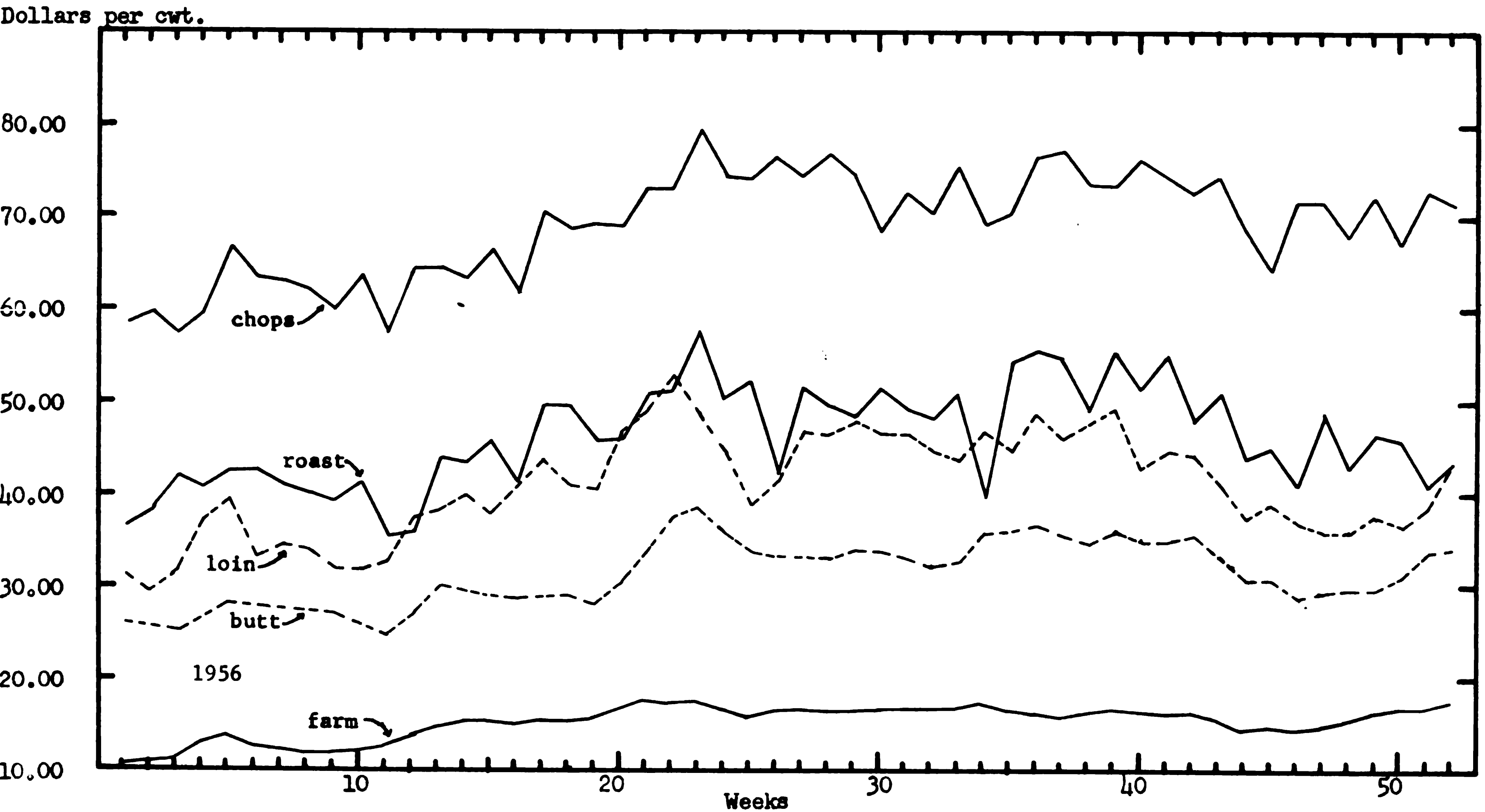


Figure 6-e. Average weekly price movements at retail, wholesale and farm level, 1956.

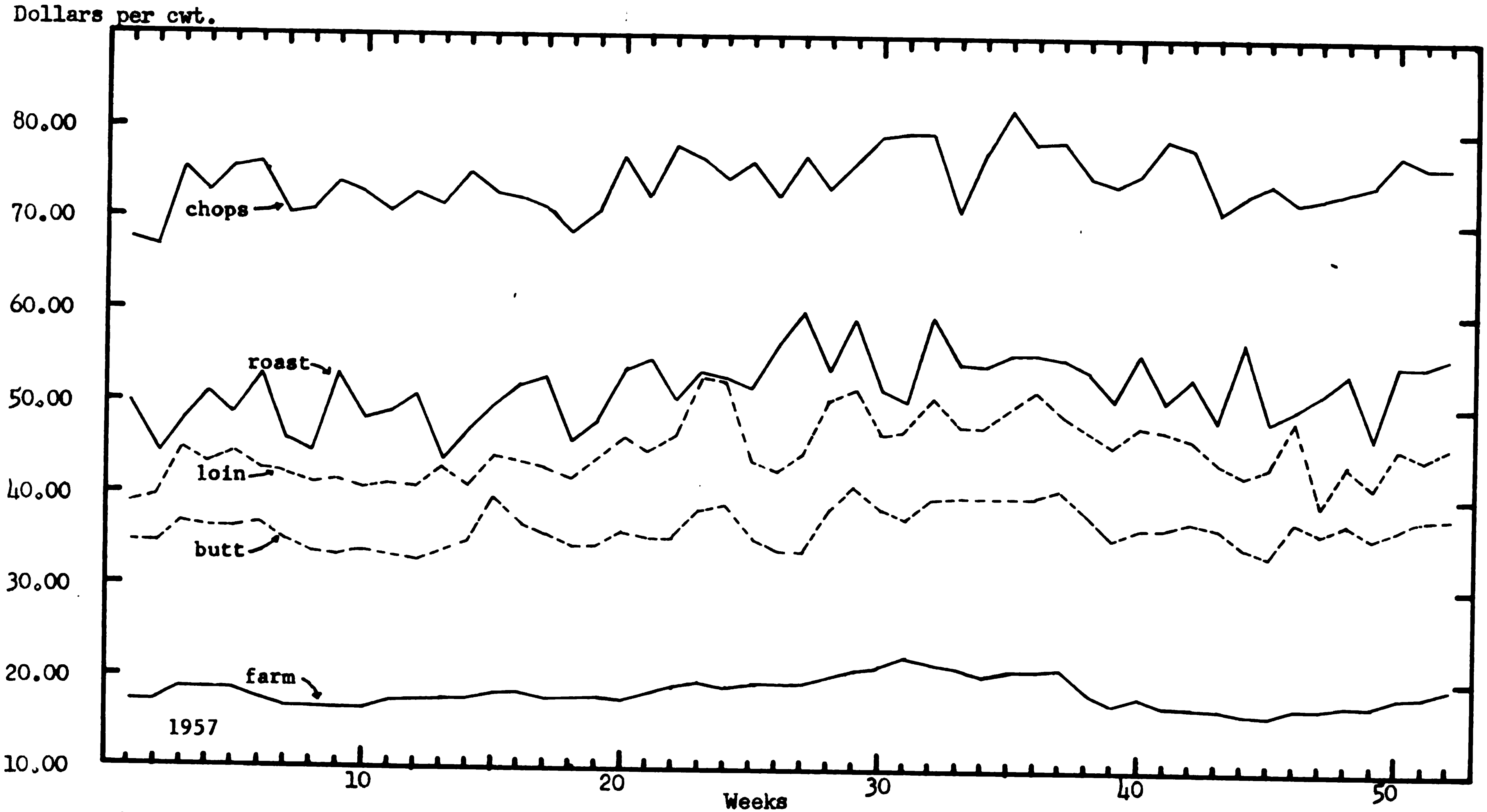


Figure 6-f. Average weekly price movements at retail, wholesale and farm level, 1957.

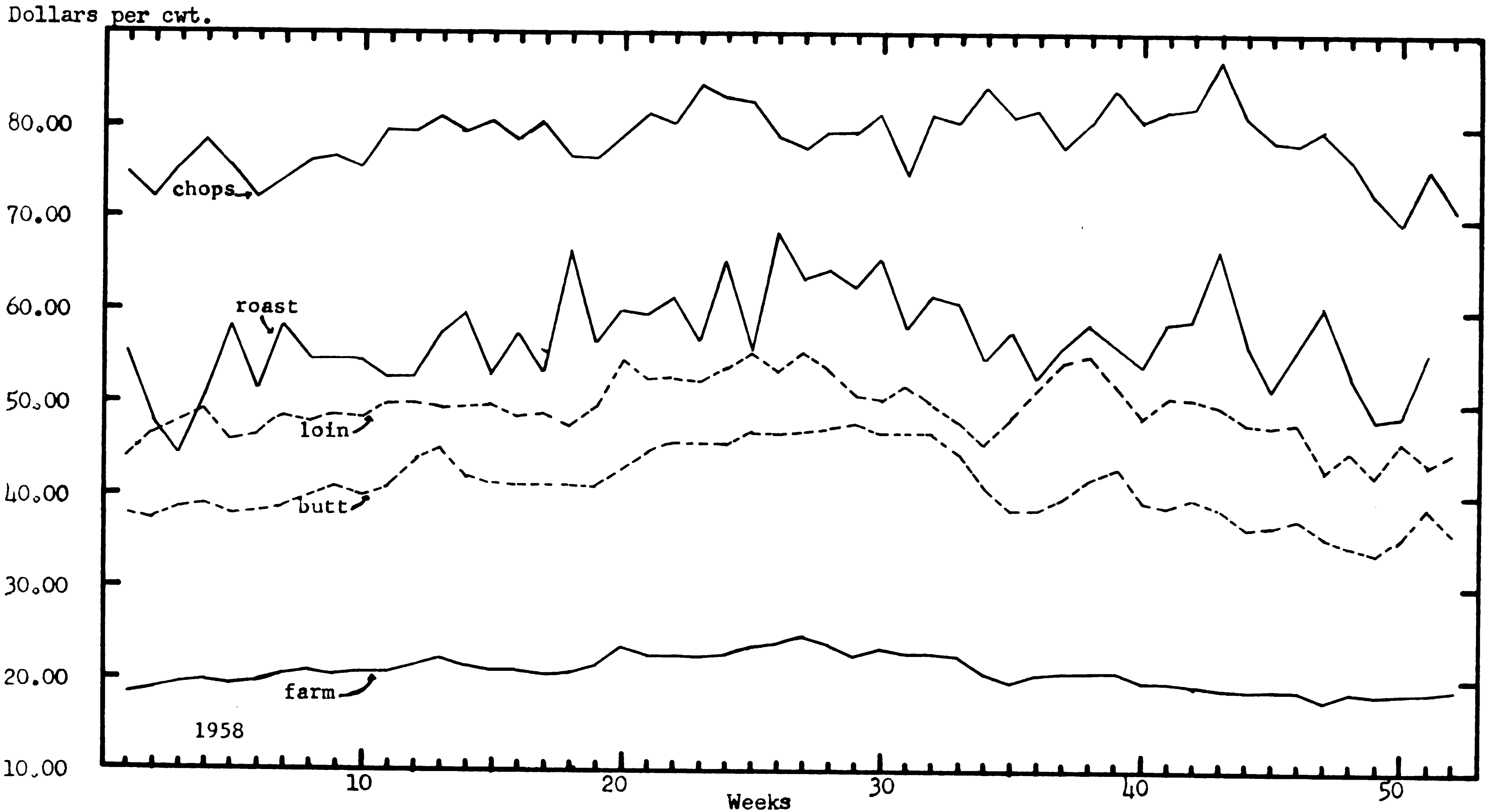


Figure 6-g. Average weekly price movements at retail, wholesale and farm level, 1958.

The equations for the mathematical calculations of the lags were formulated as follows:

Set 8.

$$(P_{r_c})_t = (\ a + b_1\ P_{w_l} + b_2\ Q_{f_p} + b_3\ Q_{f_b})_t \qquad (8.0)$$

. . . . . (8.1)

. . . . . (8.2)

$$(P_{r_c})_t = (\ a + b_1\ P_{w_l} + b_2\ Q_{f_p} + b_3\ Q_{f_b})_{t-3} \qquad (8.3)$$

Set 9.

$$(P_{r_r})_t = (\ a + b_1\ P_{w_s} + b_2\ Q_{f_p} + b_3\ Q_{f_b})_t \qquad (9.0)$$

. . . . . (9.1)

. . . . . (9.2)

$$(P_{r_r})_t = (\ a + b_1\ P_{w_s} + b_2\ Q_{f_p} + b_3\ Q_{f_b})_{t-3}. \qquad (9.3)$$

Set 10.

$$(P_{r_r})_t = (\ a + b_1\ P_{w_l} + b_2\ Q_{f_p} + b_3\ Q_{f_b})_t \qquad (10.0)$$

. . . . . (10.1)

. . . . . (10.2)

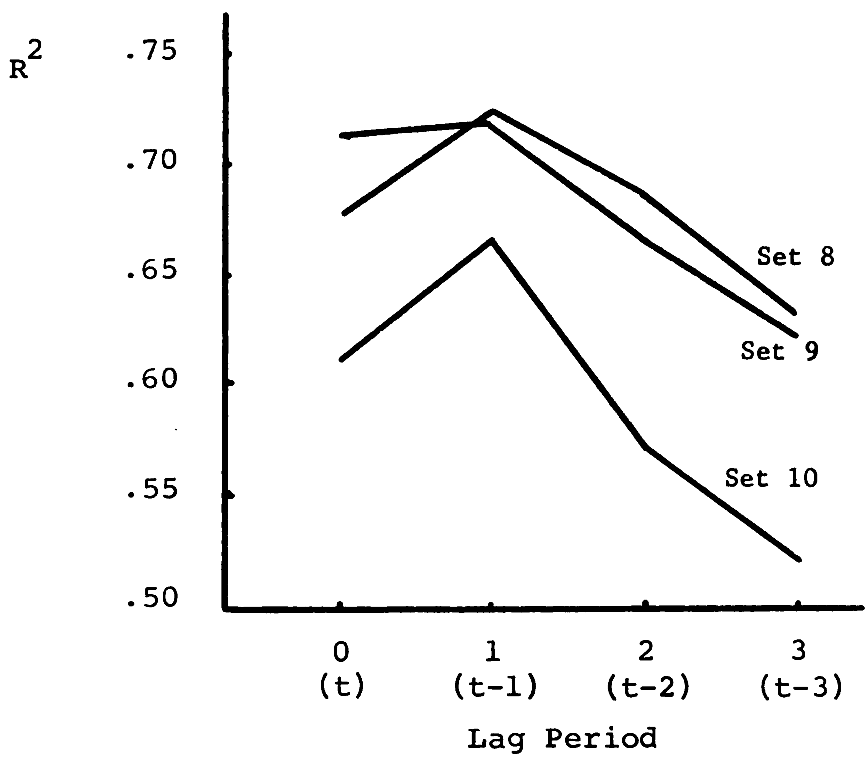
$$(P_{r_r})_t = (\ a + b_1\ P_{w_l} + b_2\ Q_{f_p} + b_3\ Q_{f_b})_{t-3}. \qquad (10.3)$$

The wholesale cuts of butts and loins were used as independent variables for roast of either of these cuts may be sold as a roast, while only loin yields pork chops. The combined period results are presented in Table 4.4, and the R^2 graphically illustrated in Figure 7.

Table 4.4 R^2 and $\hat{S}_u^2$ from sets 8, 9, and 10 by lag period.

Set		0	1	2	3
8	R^2	.676	.725	.684	.630
	$\hat{S}_u^2$	.127	.107	.123	.144
9	R^2	.713	.716	.664	.622
	$\hat{S}_u^2$	.139	.138	.164	.185
10	R^2	.612	.663	.574	.523
	$\hat{S}_u^2$	.188	.163	.207	.233

Figure 7. Graphic illustration of the coefficients of determination obtained from equation sets 8, 9, 10 and 11, by lag periods.



From Figure 7 there appears to be a one week lag in retail prices. To determine if this difference is significant the lagged equations in each set were compared by the F ratio test. As in the farm to retail sets, the equations in each set that were lagged one week had a smaller $\hat{S}_u^2$ and a larger R^2. In computing the F ratio the $\hat{S}_u^2$ of the equation lagged one week was used as the denominator. In this way each equation was compared with the equation containing the largest R^2. The F ratio tests were made in the following manner:

Set 8.

$$\frac{\hat{S}^2_{u_{8.0}}}{\hat{S}^2_{u_{8.1}}} = F^{**}_{8.0-8.1} \; (1.19) < \text{critical value} \; (1.20)$$

$$\frac{\hat{S}^2_{u_{8.2}}}{\hat{S}^2_{u_{8.1}}} = F_{8.2-8.1} \; (1.15) < \text{critical value} \; (1.20)$$

$$\frac{\hat{S}^2_{u_{8.3}}}{\hat{S}^2_{u_{8.1}}} = F^{*}_{8.3-8.1} \; (1.34) > \text{critical value} \; (1.20)$$

*Significant at the .05 level.
**Approaches very closely to the significant level.

$$\frac{\hat{S}^2_{u_{9.0}}}{\hat{S}^2_{u_{9.1}}} = F_{9.0-9.1} \underset{(1.01)}{} < \text{critical value } (1.20)$$

(1.01) (1.20)

Set 9.

$$\frac{\hat{S}^2_{u_{9.2}}}{\hat{S}^2_{u_{9.1}}} = F^{**}_{9.2-9.1} < \text{critical value}$$

(1.19) (1.20)

$$\frac{\hat{S}^2_{u_{9.3}}}{\hat{S}^2_{u_{9.1}}} = F^{*}_{9.3-9.1} > \text{critical value}$$

(1.34) (1.20)

$$\frac{\hat{S}^2_{u_{10.0}}}{\hat{S}^2_{u_{10.1}}} = F_{10.0-10.1} < \text{critical value}$$

(1.15) (1.20)

Set 10.

$$\frac{\hat{S}^2_{u_{10.2}}}{\hat{S}^2_{u_{10.1}}} = F^{*}_{10.2-10.1} > \text{critical value}$$

(1.26) (1.20)

$$\frac{\hat{S}^2_{u_{10.3}}}{\hat{S}^2_{u_{10.1}}} = F^{*}_{10.3-10.1} > \text{critical value}$$

(1.43) (1.20)

*Significant at the .05 level.
**Approaches very closely to the significant level.

Even though the results were not significant in all cases, it was still assumed that there was a lag of one week from wholesale to retail level. In all cases, a lag of three weeks had significantly larger $\hat{S}_u^2$ than a lag of one week; therefore, it is safe to assume that the lag is not three weeks. The smallest F ratios were computed using $\hat{S}_u^2$ of a one week lag and the $\hat{S}_u^2$ of the equations not lagged. This suggests the possibility of a lag in terms of days rather than weeks. Also the difference in the various sets brings forth the possibility of different cuts having different lags. However, on an over-all basis, the assumption that there is a one week lag in wholesale to retail level appears to be a reasonable one.

In inspecting the signs of the b_i values, the expected signs were present in sets 8 and 9. Set 10, however, had erratic signs. Equation 10.0 had positive signs on both the b_i of Q_{f_p} and Q_{f_b}; equations 10.1 and 10.2 had a positive sign for the b_i value for Q_{f_p} and a negative sign for the b_i for Q_{f_b}; and equation 10.3 had both negative signs. The signs were "correct" under the assumed lagged relationship of one week. Again this is noted as a possible area for further investigation.

CHAPTER V

LAGS WHEN CONSIDERING DIRECTION OF PRICE CHANGE

Farm to Wholesale

To determine the effect of price change on lags, a dummy variable was designed to denote the direction of the price change and used as an independent variable. It was felt that if a significantly smaller $\hat{S}_u^2$ was found in the equations using the dummy variable than in those equations not using the dummy variable this would indicate that the lag would be different for price changes of different directions. It was expected, a priori, that a rising market would have less lag than a lowering one. This approach would not indicate the correct lag for different price changes, but would indicate whether the possibility of a difference in lag exists.

The two wholesale cuts were set as functions of the farm price of pork (P_{f_p}), farm quantity of pork and beef (Q_{f_p} and Q_{f_b}) and a dummy variable, X_{12}. The equations were of the following form:

$$(P_{w_1})_t = (a + b_1 P_{f_p} + b_2 Q_{f_p} + b_3 Q_{f_b} + b_4 X_{12})_t \quad (11.0)$$

Set 11

$$. \quad . \quad . \quad . \quad . \quad . \quad (11.1)$$

$$. \quad . \quad . \quad . \quad . \quad . \quad (11.2)$$

$$(P_{w_1})_t = (a + b_1 P_{f_p} + b_2 Q_{f_p} + b_3 Q_{f_b} + b_4 X_{12})_{t-3} \quad (11.3)$$

$$(P_{w_s})_t = (a + b_1 P_{f_p} + b_2 Q_{f_p} + b_3 Q_{f_b} + b_4 X_{12})_t \quad (12.0)$$

Set 12

$$. \quad . \quad . \quad . \quad . \quad . \quad (12.1)$$

$$. \quad . \quad . \quad . \quad . \quad . \quad (12.2)$$

$$(P_{w_s})_t = (a + b_1 P_{f_p} + b_2 Q_{f_p} + b_3 Q_{f_b} + b_4 X_{12})_{t-3} \quad (12.3)$$

where $X_{12} = 0$ if the change in P_{f_p} is positive from observation period t-1 to t and 1 if there is no change or the change is a negative one.

The equations were calculated and the resulting R^2 and $\hat{S}_u^2$ presented in Table 5.1. Since comparisons will be made between equations using the dummy variable and those equations that have the same variables except the dummy one, R^2 and $\hat{S}_u^2$ from equation sets 4 and 5 are also presented in Table 5.1.

Statistical tests of significance could have been made between the equations with the dummy variables and those without the dummy variables. However, by inspection of the R^2 and $\hat{S}_u^2$ of the various sets it was obvious that the difference in the equations that used the dummy variables and those not using them was not statistically significant.

From this it was concluded that the dummy variable added nothing to the explanation of the dependent variables.

Table 5.1 R^2 and $\hat{S}_u^2$ from equation sets 4, 5, 11, and 12, by lagged period.

Set		0	1	2	3
11	R^2	.778	.756	.726	.678
	$\hat{S}_u^2$	10.81	11.87	13.35	15.72
4	R^2	.776	.754	.715	.675
	$\hat{S}_u^2$	10.85	11.94	13.86	15.82
12	R^2	.897	.885	.847	.796
	$\hat{S}_u^2$	4.10	4.60	6.13	8.20
5	R^2	.892	.884	.843	.790
	$\hat{S}_u^2$	4.31	4.61	6.28	8.44

Farm to Retail

In determining the farm to retail lag, the dummy variable, X_{12}, was used. The equations used were of the following form:

Set 13

$$(P_{r_c})_t = (a + b_1 P_{f_p} + b_2 Q_{f_p} + b_3 Q_{f_b} + b_4 X_{12})_t \quad (13.0)$$

$$\cdot \quad \cdot \quad \cdot \quad \cdot \quad \cdot \quad \cdot \quad (13.1)$$

$$\cdot \quad \cdot \quad \cdot \quad \cdot \quad \cdot \quad \cdot \quad (13.2)$$

$$(P_{r_c})_t = (a + b_1 P_{f_p} + b_2 Q_{f_p} + b_3 Q_{f_b} + b_4 X_{12})_{t-3} \quad (13.3)$$

Set 14

$$(P_{r_r})_t = (a + b_1 P_{f_p} + b_2 Q_{f_p} + b_3 Q_{f_b} + b_4 X_{12})_t \quad (14.0)$$

$$\cdot \quad \cdot \quad \cdot \quad \cdot \quad \cdot \quad \cdot \quad (14.1)$$

$$\cdot \quad \cdot \quad \cdot \quad \cdot \quad \cdot \quad \cdot \quad (14.2)$$

$$(P_{r_r})_t = (a + b_1 P_{f_p} + b_2 Q_{f_p} + b_3 Q_{f_b} + b_4 X_{12})_{t-3} \quad (14.3)$$

The variables used in these equations were the same as those used in sets 6 and 7 with the addition of the dummy variable. Set 13 corresponds to set 6 and set 14 corresponds to set 7. Therefore, comparisons will be made between sets 6 and 13 and sets 7 and 14. Sets 13 and 14 were calculated and the resulting R^2 and $\hat{S}_u^2$ appear in Table 5.3 along with the R^2 and $\hat{S}_u^2$ from sets 6 and 7.

F ratio tests could have been computed using the $\hat{S}_u^2$ to determine whether the dummy variable had reduced the $\hat{S}_u^2$ by a significant amount. This was not done because inspection of the $\hat{S}_u^2$ in Table 5.2 indicates that the ratios obtained would be very close to unity if not at unity. In no case would the F ratio approach the critical value of 1.20. From this it was concluded that the dummy variable added no significant information over the variables previously used.

Table 5.2. R^2 and $\hat{S}_u^2$ from equation sets 6, 7, 13, and 14 by lag period.

Set		0	1	2	3
13	R^2	.747	.755	.745	.721
	$\hat{S}_u^2$	.099	.096	.099	.108
6	R^2	.729	.753	.745	.721
	$\hat{S}_u^2$	.106	.096	.099	.108
14	R^2	.701	.700	.673	.644
	$\hat{S}_u^2$	.145	.146	.159	.174
7	R^2	.683	.699	.673	.643
	$\hat{S}_u^2$	.153	.146	.159	.174

The b_i coefficients were consistent between the sets being compared. This tends to add support to the conclusion that the dummy variable is of no significant value in the explanation of the dependent variable. That is, there does not appear to be a difference in the farm to retail lag between increasing and decreasing prices.

Wholesale to Retail

In determining the wholesale to retail lag, two new dummy variables were formulated. They were used in the following regression equations:

Set 15

$$(P_{r_c})_t = (a + b_1 P_{w_1} + b_2 Q_{f_p} + b_3 Q_{f_b} + b_4 X_{13})_t \quad (15.0)$$

$$. \quad . \quad . \quad . \quad . \quad . \quad (15.1)$$

$$. \quad . \quad . \quad . \quad . \quad . \quad (15.2)$$

$$(P_{r_c})_t = (a + b_1 P_{w_1} + b_2 Q_{f_p} = b_3 Q_{f_b} + b_4 X_{13})_{t-3} \quad (15.3)$$

where $X_{13} = 0$ if the change in P_{w_1} from observation period t-1 to t is positive and 1 if there was no change from t-1 to t or if the change was negative.

Set 16

$$(P_{r_r})_t = (a + b_1 P_{w_s} + b_2 Q_{f_p} + b_3 Q_{f_b} + b_4 X_{14})_t \quad (16.0)$$

$$. \quad . \quad . \quad . \quad . \quad . \quad (16.1)$$

$$. \quad . \quad . \quad . \quad . \quad . \quad (16.2)$$

$$(P_{r_r})_t = (a + b_1 P_{w_s} + b_2 Q_{f_p} + b_3 Q_{f_b} + b_4 X_{14})_{t-3} \quad (16.3)$$

where $X_{14} = 0$ if the change in P_{w_s} is positive from observation period t-1 to t and 1 if there was no change or if the change was negative.

Set 17

$$(P_{r_r})_t = (a + b_1 P_{w_1} + b_2 Q_{f_p} + b_3 Q_{f_b} + b_4 X_{13})_t \quad (17.0)$$

$$. \quad . \quad . \quad . \quad . \quad . \quad (17.1)$$

$$. \quad . \quad . \quad . \quad . \quad . \quad (17.2)$$

$$(P_{r_r})_t = (a + b_1 P_{w_1} + b_2 Q_{f_p} + b_3 Q_{f_b} + b_4 X_{13})_{t-3} \quad (17.3)$$

As in the previous sets of equations in this chapter, the above sets have corresponding sets differing only in the addition of the dummy variable. When comparing sets of equations, sets 15 and 8, 16 and 9, and 17 and 10 will be compared. The R^2 and $\hat{S}_u^2$ from the various sets are presented in Table 5.3.

Table 5.3. R^2 and $\hat{S}_u^2$ from equation sets 8, 9, 10, 15, 16, and 17 by lag periods.

Set		0	1	2	3
15	R^2	.699	.728	.687	.631
	$\hat{S}_u^2$	.118	.106	.122	.144
8	R^2	.676	.725	.684	.630
	$\hat{S}_u^2$	.127	.107	.123	.144
16	R^2	.729	.716	.681	.624
	$\hat{S}_u^2$	.136	.138	.156	.184
9	R^2	.713	.716	.664	.622
	$\hat{S}_u^2$	.139	.138	.164	.185
17	R^2	.650	.667	.576	.537
	$\hat{S}_u^2$	.170	.162	.207	.230
10	R^2	.612	.663	.574	.523
	$\hat{S}_u^2$	.188	.163	.207	.233

As in the previous sections of this chapter, F ratio tests were not computed as it was obvious that all such ratioswould be very close to unity when testing comparable equations. There was very little absolute difference in either R^2 or the $\hat{S}_u^2$ between similar sets.

The signs of the b coefficients were consistent between comparable sets of equations.

As in the previous sections of this chapter, it was concluded that the dummy variable is of no significant value in explaining the dependent variable.

Summary

The dummy variable proved to be of no significant value in that R^2 wasn't increased or $\hat{S}_u^2$ decreased by significant amounts. This seems to indicate that the direction of price change does not influence the lag in price response. Further study, however, would need to be made before definite conclusions could be drawn.

CHAPTER VI

MARGINS

Farm to Wholesale Value

The farm to wholesale margin was defined as $(P_{w_p} - P_{f_p})_t$. The time was not lagged as there was no apparent lag between P_{f_p} (farm price of pork) and P_{w_p} (wholesale value of pork). To estimate the coefficients, a regression equation of the following form was used:

$$\text{Eq. 18} \quad (P_{w_p} - P_{f_p})_t = (a + b_1 P_{f_p} + b_2 Q_{f_p})_t \qquad 18.0$$

The R^2 resulting from equation 18.0 was .361 which is relatively small. The b_1 coefficient was -.064 and the b_2 coefficient was .0001. This seems to indicate the effect that farm price is normally thought to have: that as P_{f_p} increases, the margin decreases. By looking at Figure 1-d and 1-e it can be noticed that during the latter part of 1955 and the early part of 1956, the margins between farm price and wholesale value became quite large. These figures show that as the quantity of hogs increased the margin increased. This reflects the accepted idea that the quantity of hogs moving through the marketing channels influences pork margins in the short run and that the larger the quantity the larger the margin.[1,2] Equation 18.0 substantiated what is normally accepted in that the simple correlations were +.519 for Q_{f_p} (farm quantity of pork) and -.529 for P_{f_p} (farm price of pork).

Farm to Wholesale Cut

The first step was to formulate the regression equations to be used. They were of the following form:

Eq. 19 $Y_1 = a + b_1 P_{f_p} + b_2 Q_{f_p}$

where $Y_1 = (P_{w_1} - P_{f_p})$. (19.0)

Eq. 20 $Y_2 = a + b_1 P_{f_p} + Q_{f_p}$ (20.0)

where $Y_2 = (P_{w_s} - P_{f_p})$.

Eq. 21 $Y_1 = a + b_1 P_{w_1} + b_2 Q_{f_p}$ (21.0)

Eq. 22 $Y_2 = a + b_1 P_{w_s} + b_2 Q_{f_p}$ (22.0)

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[1] Harold F. Breimyer, "Price Determination and Aggregate Price Theory," Journal of Farm Economics, Vol. XXIX (1958), p. 691.

[2] One could say that the farm quantity of pork influences the farm price which in turn influences the margins. Farm quantity of pork has an inverse relationship with farm price of pork; therefore, as farm price goes up, margins go down. In this way, farm price influences pork margins.

This set of margins as functions of either the farm level price or of the wholesale level price used in computing the margin. The variable, farm quantity of hogs (Q_{f_p}), was used because the quantity of hogs moving through the marketing channels was believed to influence the margins. The R^2 from the above equations are presented in Table 6.1.

The specific wholesale cut price seems to be a relatively good indicator even when used without the variable, farm quantity of hogs. This is shown in the R^2 deletes given in Table 6.1. Perhaps by adding a variable outside of the information being considered in this thesis, such as industrial wage rates, R^2 could be increased.

The equations having the same dependent variables were tested by the F ratio for significance. As was expected, the equations using P_{f_p} as an independent variable differed significantly from the equations using a specific wholesale cut price as an independent variable. This difference was shown in the larger $\hat{S}_u^2$ of the equation using P_{f_p} as an independent variable.

$$\frac{\hat{S}^2_{u_{19.0}}}{\hat{S}^2_{u_{21.0}}} = \underset{(2.90)}{F_{19.0-21.0}} > \underset{(1.20)}{\text{critical value}}$$

$$\frac{\hat{S}^2_{u_{20.0}}}{\hat{S}^2_{u_{22.0}}} = F_{20.0-21.0} > \text{critical value}$$

$$(3.25) \qquad (1.20)$$

Table 6.1. R^2 and R^2 deletes* from equations 19, 20, 21 and 22 by lag periods.

Equation	Variable	R^2	R^2 delete
19.0	P_{f_p}	.397	.324
	Q_{f_p}		.279
21.0	P_{w_l}	.793	.324
	Q_{f_p}		.739
20.0	P_{f_p}	.560	.087
	Q_{f_p}		.549
22.0	P_{w_s}	.865	.087
	Q_{f_p}		.848

*R^2 delete is the R^2 associated with the equation had that variable been dropped.

It was expected that the specific wholesale cut would be a "better" independent variable to explain its own margin than would be the farm price of pork.

Farm to Retail

The first step was to define the margin as the difference of the retail price of a specific cut at a given week (t) and the farm price of pork at the assumed lagged relationship of one week (t-1). The margin for pork chops was $(P_{r_c})_t - (P_{f_p})_{t-1}$ which was designated as Y_3. The margin for pork roast was $(P_{r_r})_t - (P_{f_p})_{t-1}$ which was designated as Y_4. These margins were set as functions of P_{f_p} and Q_{f_p} in the following form:

Eq. 23 $Y_3 = (a + b_1 P_{f_p} + b_2 Q_{f_p})_{t-1}$ (23.1)

Eq. 24 $Y_4 = (a + b_1 P_{f_p} + b_2 Q_{f_p})_{t-1}$ (24.1)

When these equations were calculated, the resulting R^2 were much smaller than was expected. R^2 was .235 for equation 23.1 and .245 for equation 24.1. The R^2 delete for equation 23.1 showed that had Q_{f_p} been dropped, the R^2 would have been reduced by approximately one-half; the delete was .124 with an R^2 of .235. In equation 24.1, Q_{f_p} added nothing as the R^2 delete for Q_{f_p} was .245 and R^2 was .245.

The margins could have been redefined on a non-lagged basis where $Y_j = (P_{r_p})_t - (P_{f_p})_t$ (where j = a specific retail cut) but since the actual difference in the variation of the margin would have been relatively slight, the R^2 from the equation could not be expected to be increased greatly.

In this approach, more information was needed to explain the action of the margins by regression. However, it was felt before the calculations were made that R^2 would not be large as the price difference between farm level and retail level was relatively large. However, larger R^2 were expected than were obtained.

The margins Y_3 and Y_4 were not set as functions of P_{r_c} or P_{r_r} as the results for the wholesale to retail margins indicated that extremely small R^2 would be obtained; therefore, these calculations were not made.

Wholesale to Retail

As in the farm to retail margin approach, the first step was to formulate the proper margin on a lagged basis. Since a lag of one week was indicated in Chapter IV, the assumed correct margin was defined as the difference between a specific retail cut at a given time (t) and a specific wholesale cut at a one week lag (t-1). The margins were $(P_{r_c})_t - (P_{w_1})_{t-1}$ which was designated as

Y_5 and $(P_{r_r})_t$ - $(P_{w_s})_{t-1}$ which was designated as Y_6. These margins were set as functions of P_{w_1}, P_{w_s}, P_{r_c} and P_{r_r} in the following manner:

Eq. 25. $$Y_5 = (a + b_1 P_{w_1} + b_2 Q_{f_p})_{t-1} \quad (25.1)$$

Eq. 26. $$Y_6 = (a + b_1 P_{w_s} + b_2 Q_{f_p})_{t-1} \quad (26.1)$$

Eq. 27. $$Y_5 = (a + b_1 P_{r_c} + b_2 Q_{f_p})_t \quad (27.0)$$

Eq. 28. $$Y_6 = (a + b_1 P_{r_r} + b_2 Q_{f_p})_t \quad (28.0)$$

These equations were then calculated and the R^2 obtained were extremely small. The R^2 was .223 for equation 25.1, .028 for equation 26.1 and .007 for equation 27.0 and 28.0. The $\hat{S}_u^2$ for these equations were very large. From the R^2 and the $\hat{S}_u^2$ it could be easily seen that this approach has no value in explaining the margins as formulated in this thesis. Because of the extremely small R^2 and the extremely large $\hat{S}_u^2$, further statistical tests were not made on these equations.

CHAPTER VII

SUMMARY AND CONCLUSIONS

Summary

This study was to determine the lag reaction of retail pork prices to changes in prices at farm and wholesale levels. It was assumed that if a lag existed it was partially due to imperfect knowledge on the part of those concerned at the higher level. It was assumed that there was imperfect knowledge on the part of retailers. It was also assumed that this imperfect knowledge was due to prices being determined by the fluctuations of an inelastic and predetermined supply and that changes in supply are first felt at the packer or wholesaler level. Based on the above assumptions of imperfect knowledge on the part of retailers and packer level price determination, it was thought that there would be no lag from farm to wholesale, but that there would be a lag from farm to retail and wholesale to retail. A hypothesis was made that if a lag was present it would differ when prices were rising than when prices were falling. A second hypothesis was made that margins could best be determined when computed on a lagged basis if the assumption that there is a lag was correct.

The data used were average weekly data, consisting of prices of selected cuts at retail and wholesale levels, farm price of U.S. 1, 2, and 3 barrows and gilts, farm quantity of U.S. 1, 2, and 3 barrows and gilts, and the farm quantity of choice beef. All of these prices were Chicago prices with the exception of retail prices which were taken from the M.S.U. Consumer Purchase Panel.

The various prices were fitted by regression equations of the following form for determining the proper lag:

$$Y_1 = a + b_i Z_i + b_i Q_i + u$$

where Y_i = a given price one level above that price used as an independent variable; Z_i = either farm or wholesale price, depending on the lag being determined; and Q_i = farm qualities of pork and beef.

The independent variables were lagged from observation t to observation t-3. This was done to determine the correct lagged relationship between the dependent and the independent variables.

An additional variable, called a dummy variable, was used to determine whether by differentiating between an upward and downward movement of the independent price variable a better explanation of the dependent variable could be obtained. This dummy variable was used in the regression equations along with the independent variable P_{f_p}, Q_{f_p} and Q_{f_b}.

Margins were computed on a lagged basis and fitted as functions of various prices and quantities of hogs.

All calculations were made by an electronic computer. Whenever statistical tests were made the probability level was P = .05.

When computed on an over-all basis which made no distinction between upward or downward price movements, there appeared to be a one week lag in farm to retail prices and in wholesale to retail prices, although this lag was not statistically significant in all cases. There appeared to be no lag between farm and wholesale prices.

The above statements were based on the findings of the regression equations and by graphic analysis. They also fulfilled an assumption made for this study and possibly indicated that the retailer has less perfect knowledge than does the packer or wholesaler. Also the pricing focal point seems to be at the packer or wholesale level.

When the quantities of pork and beef were used along with a specific level of price, Q_{f_b} (farm quantity of beef) took on a different sign than was expected. This was due to the intercorrelation between Q_{f_p} and Q_{f_b} which caused the b value associated with Q_{f_b} to actually measure the effect of Q_{f_p} (farm quantity of pork) rather than itself. Since the correlation between Q_{f_p} and Q_{f_b} was negative, the assumption was made that the b value associated with Q_{f_b} would take on the opposite sign of the b value associated with Q_{f_p}. This assumption held true in most cases.

When the dummy variable approach was used, the dummy variable seemed to have no significant value in that it added little to R^2 and did not reduce S_u^2 by any significant amount. This could indicate that there is no difference in lag between a rising and falling market. If there is no difference in lag when the market is rising from when the market is lowering, the possibility of the lag being based on a knowledge situation loses validity. If the lag is the same in either market, this would seem to indicate that the lag is of a technological nature. On a knowledge basis, one can assume that retailers would prefer to make a mistake in over pricing than one of under pricing. On upward price movements, retailers would respond relatively quick to keep from taking a loss; while on a downward market, one could assume that retailers would prefer to wait for a trend to be established before changing prices. If there is no difference in lag, then the possibility of the pricing policies and habits of retailers determining the lag is substantiated. A lag of this nature would be a technological one rather than one based on uncertainty.

The margins proved to have no positive value when formulated on a lagged basis. The only conclusion that could be drawn was that the approach used in this thesis cannot explain the movements of margins by the movements of the various prices and quantities of hogs. More information that is outside the approach used for this thesis would be needed to provide an adequate explanation of margins.

Conclusions

There are four main conclusions of this thesis. These are: (1) there is no lag between farm and wholesale price; (2) there is a one week lag between farm and retail prices and between wholesale and retail prices; (3) a dummy variable that denotes the direction of the price change for the independent variable was of no significant value in explaining the movements of the dependent variable and there is no difference in lag between an upward and downward market; and (4) margins cannot be explained by price and quantity alone.

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APPENDIX

ASSUMPTIONS OF STATIC ECONOMICS[1]

1. Assumptions which fix the production functions of the economy:

   a. The state of the arts is assumed constant, i.e., the total production of any set of production factors remains fixed.

2. Assumptions which fix the utility functions of the economy:

   a. Tastes, habits, customs (i.e., everything affecting utility functions) are assumed fixed.

   b. The ownership pattern for resources and, hence, the equilibrium distribution of private real incomes is assumed fixed.

   c. Population is assumed constant.

   d. Utility functions are independent among people, i.e., jealousy and "copying" of tastes and value systems are absent.

3. Assumptions which specify the institutional set-up of the economy.

   a. Government is assumed fixed.

   b. It is assumed that goods and services are sold in a market where both producing and consuming individuals and groups can make their choices free of force or coercion but with consumers subject, however, to limitations imposed by their real incomes.

   c. Non-firm and non-household groups are assumed fixed.

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[1]Dr. Glenn L. Johnson, Agr. Econ. 854, class notes, Winter, 1962, Michigan State University.

APPENDEX II

The following tables contain the data used in this thesis.

Table II a. Data for the year 1952.

Week	P_{r_c} ¢/lb.	P_{r_r} ¢/lb.	P_{f_p} \$/cwt	Q_{f_p} head	P_{w_p} \$/cwt	P_{w_l} \$/cwt	P_{w_s} \$/cwt	Q_{f_b} head
1	.661	.508	18.06	50,364	20.21	42.00	39.00	9,338
2	.665	.525	17.79	75,482	20.27	40.67	39.00	10,421
3	.641	.541	17.69	65,778	20.18	40.75	38.00	9,253
4	.687	.538	17.77	64,375	20.08	40.91	38.00	12,285
5	.652	.483	17.73	55,452	19.70	39.50	37.25	10,158
6	.628	.520	17.62	55,732	19.84	39.50	37.25	9,508
7	.659	.491	17.49	57,936	19.82	39.08	37.00	8,861
8	.635	.504	17.16	44,612	19.70	39.91	38.00	10,196
9	.640	.506	16.85	44,543	19.54	40.33	38.00	9,562
10	.658	.530	16.89	39,607	19.73	43.00	38.00	8,917
11	.664	.500	16.87	44,451	19.70	43.85	38.00	9,355
12	.640	.500	16.76	47,944	19.73	43.85	38.00	[illegible]
13	.639	.548	16.64	46,152	19.28	43.84	37.00	10,657
14	.663	.508	16.57	43,070	16.66	39.17	37.00	[illegible]
15	.661	.469	16.66	34,585	18.85	39.17	37.00	[illegible]
16	.603	.492	16.81	39,751	19.44	43.83	38.00	[illegible]
17	.660	.510	17.05	38,717	19.18	41.70	37.50	[illegible]
18	.670	.552	17.49	38,992	19.54	45.17	37.50	11,773
19	.690	.556	19.49	40,069	20.92	53.17	40.00	[illegible]
20	.722	.555	20.22	34,618	21.70	53.17	43.00	[illegible]
21	.762	.515	21.42	35,030	22.30	53.17	44.40	11,375
22	.765	.591	20.79	28,374	22.38	53.17	44.00	[illegible]
23	.743	.633	20.69	41,811	22.26	53.17	42.50	12,525
24	.760	.571	20.23	30,673	22.12	53.17	40.50	13,174
25	.740	.514	20.25	28,520	21.70	51.53	38.70	11,475
26	.738	.587	20.20	28,520	21.55	49.00	37.00	10,723
27	.770	.548	21.05	19,469	21.93	49.08	37.75	9,744
28	.713	.607	21.40	28,998	22.30	50.17	40.10	17,315
29	.757	.583	21.70	24,889	22.64	52.92	42.00	[illegible]
30	.698	.561	22.52	19,793	22.91	52.92	43.00	12,653
31	.767	.586	23.09	23,834	24.19	59.36	47.80	14,441
32	.758	.643	22.67	18,908	24.24	60.97	48.00	17,554
33	.769	.635	22.11	17,051	23.90	59.53	46.30	17,719
34	.780	.623	21.77	21,158	23.74	58.37	43.70	16,235
35	.784	.631	20.65	20,024	23.27	55.73	41.60	15,655

Table II a. Data for the year 1952, continued.

Week	P_{r_c} ¢/lb.	P_{r_r} ¢/lb.	P_{f_p} \$/cwt	Q_{f_p} head	P_{w_p} \$/cwt	P_{w_l} \$/cwt	P_{w_s} \$/cwt	Q_{f_b} head
36	.770	.606	20.49	18,667	22.35	52.17	41.50	13,782
37	.784	.609	19.86	24,559	21.43	52.50	40.40	18,379
38	.790	.601	19.18	26,475	22.34	53.50	39.30	15,414
39	.780	.592	20.30	27,164	22.26	54.54	39.40	14,456
40	.783	.552	20.54	30,498	21.86	54.67	39.50	14,363
41	.787	.615	19.77	34,105	21.31	53.87	39.10	16,553
42	.792	.614	19.31	39,369	20.80	50.57	38.50	17,478
43	.744	.567	18.60	43,502	20.08	45.70	37.40	15,357
44	.743	.576	17.44	46,733	18.93	41.00	35.90	14,214
45	.709	.496	17.71	40,083	19.19	41.80	35.25	12,631
46	.702	.537	17.20	50.471	19.96	44.90	36.62	13,147
47	.700	.517	16.77	70,755	19.16	38.80	34.00	14,207
48	.739	.513	16.63	45,054	18.95	36.00	32.25	9,233
49	.675	.509	16.57	68,003	19.11	36.27	32.00	10,650
50	.694	.443	16.44	71,127	18.99	36.33	32.00	11,519
51	.669	.494	16.45	64,128	19.27	36.60	33.90	12,590
52	.668	.510	18.03	38,513	20.04	38.62	36.67	4,686

Table II b. Data for the year 1953.

Week	P_{r_c} ¢/lb.	P_{r_r} ¢/lb.	P_{f_p} \$/cwt	Q_{f_p} head	P_{w_p} \$/cwt	P_{w_l} \$/cwt	P_{w_s} \$/cwt	Q_{f_b} head
1	.683	.498	17.68	67,153	20.38	39.83	37.00	10.668
2	.673	.517	18.29	64,204	20.79	40.23	37.00	12,881
3	.718	.509	18.15	64,024	21.02	40.06	36.70	12,436
4	.703	.550	18.66	50,533	21.20	40.03	36.90	10,990
5	.667	.503	18.65	46,524	20.75	39.45	37.30	9,970
6	.713	.459	18.73	39,974	20.70	39.95	36.80	11,383
7	.694	.515	19.87	37,179	21.70	45.60	39.70	13,736
8	.706	.571	20.29	34,371	21.91	47.90	42.00	12,870
9	.760	.573	20.14	34,034	21.96	47.08	40.38	11,670
10	.762	.557	20.54	36,393	22,03	46,57	40.20	14,342
11	.722	.560	20.79	33,314	22.07	45,96	39.20	14,696
12	.709	.525	21.15	34,410	22.34	47.07	41.20	12,510
13	.746	.571	20.62	34,521	22.30	46.92	42.80	12,129
14	.696	.556	20.97	27,608	21.98	44.98	42.50	11,506
15	.699	.590	21.47	29,122	22.24	45,63	42.10	15,006
16	.714	.595	21.72	31,774	22.81	47.50	42.80	19,211
17	.774	.591	23.40	28.087	25.00	59.97	47.40	19,505
18	.837	.620	23.36	31,193	24.87	58.03	48.50	17,853
19	.808	.611	23.86	25,811	24.69	54.25	48.30	18,732
20	.781	.664	24.55	24,339	24,87	53,97	48.90	17,705

Table II b. Data for the year 1953, continued.

Week	P_{r_c} ¢/lb.	P_{r_r} ¢/lb.	P_{f_p} $/cwt	Q_{f_p} head	P_{w_p} $/cwt	P_{w_l} $/cwt	P_{w_s} $/cwt	Q_{f_b} head
21	.827	.573	24.38	25,109	25.52	55.35	49.60	14,388
22	.859	.615	24.89	25,196	26.48	60.37	51.50	16,591
23	.891	.652	25.60	26,625	26.68	61.50	51.90	18,266
24	.644	.652	24.17	21,085	25.70	53.30	48.40	21,427
25	.803	.618	24.98	21,709	25.70	52.47	48.15	24,604
26	.787	.619	25.46	24,173	26.10	54.87	49.00	20,283
27	.836	.635	25.39	16,916	26.33	53.14	49.30	18,767
28	.820	.604	25.77	16,565	26.84	55.20	49.30	19,363
29	.815	.635	26.90	15,745	27.81	60.67	51.35	16,365
30	.873	.678	26.54	14,591	28.46	65.83	52.60	15,531
31	.846	.704	25.39	15,701	27.02	52.60	51.00	18,997
32	.850	.585	22.92	16,391	25.85	49.03	48.20	19,486
33	.825	.602	24.75	13,421	26,76	56.63	48.55	18,062
34	.843	.676	25.66	16,697	27.60	60.87	50.00	17,813
35	.866	.631	24.98	20,786	27.12	54.40	48.70	16,194
36	.830	.601	24.16	15,143	25.26	54.80	45.00	11,524
37	.785	.643	24.79	21,308	26.98	55.79	48.38	11,431
38	.808	.643	25.02	26,246	27.10	56.03	47.50	21,483
39	.817	.642	25.04	27,056	25.92	51.27	47.60	15,632
40	.817	.563	24.57	31,855	25.48	53.70	47.20	15,025
41	.788	.615	22.17	35,426	23.31	46.10	44.70	17,091
42	.779	.553	22.03	35,582	23.60	51.90	40.60	16,187
43	.807	.560	21.53	40,739	23.75	49.80	39.00	14,504
44	.735	.580	20.61	47,846	22.62	46.20	37.70	13,904
45	.771	.536	20.62	48,574	21.93	44.90	37.40	16,937
46	.739	.531	20.45	43,935	22.47	44.12	36.00	13,684
47	.733	.633	20.93	41,770	22.38	40.30	34.30	16,182
48	.700	.538	22.24	32,266	23.34	42.33	36.25	13,863
49	.715	.535	23.46	51,988	24.40	45.75	40.30	12.422
50	.734	.521	23.55	39,777	25,47	47.33	44.30	15,134
51	.771	.569	24.12	41,622	25.50	47.33	47.00	14,173
52	.758	.652	24.98	27,530	26.76	51.58	49.75	10,502

Table II c. Data for the year 1954.

Week	P_{r_c} ¢/lb.	P_{r_r} ¢/lb.	P_{f_p} \$/cwt	Q_{f_p} head	P_{w_p} \$/cwt	P_{w_l} \$/cwt	P_{w_s} \$/cwt	Q_{f_b} head
1	.789	.593	24.86	41,705	27.44	56.27	52.25	14,855
2	.825	.657	24.27	44,735	27.17	52.63	49.50	13,557
3	.797	.589	25.24	43,537	28.14	55.20	51.00	14,223
4	.807	.606	25.38	40,657	27.62	51.20	48.20	15,372
5	.817	.591	25.92	32,342	27.85	50.53	48.00	11,055
6	.808	.588	25.70	30,048	27.17	48.93	48.00	12,404
7	.779	.590	25.66	28,939	27.27	51.03	48.60	12,398
8	.800	.550	26.03	26,587	27.88	54.60	49.60	14,810
9	.790	.591	25.61	28,939	28.10	56.25	50.00	12,042
10	.817	.604	25.60	26,980	27.41	53.10	48.60	14,979
11	.850	.617	25.38	29,960	27.28	51.33	47.40	13,016
12	.807	.596	25.70	28,943	27.58	51.00	47.00	14,297
13	.764	.619	26.57	25,725	28.21	53.80	47.60	13,354
14	.807	.629	26.85	25,910	28.72	56.67	49.00	14,682
15	.801	.606	27.05	26,721	28.76	55.87	50.00	13,028
16	.846	.639	27.54	23,388	29.07	55.06	50.00	12,441
17	.820	.600	27.85	28,682	29.78	57.67	49.80	16,500
18	.814	.659	26.90	28,926	28.78	55.67	47.95	12,034
19	.800	.609	26.30	26,224	28.21	55.13	46.80	17,074
20	.804	.638	26.32	27,733	28.87	61.77	47.00	20,253
21	.845	.663	26.38	35,431	29.07	64.03	47.60	21,793
22	.864	.674	25.21	30,061	28.01	59.20	44.10	18,373
23	.832	.618	25.06	23,734	28.15	61.17	45.00	18,055
24	.879	.573	24.34	28,022	27.32	58.93	46.60	21,337
25	.802	.567	22.57	19,333	25.49	50.70	40.80	19,438
26	.793	.504	23.89	18,030	26.28	54.17	40.50	15,617
27	.764	.631	23.95	18,191	26.23	57.37	42.40	14,802
28	.789	.680	23.35	24,450	25.86	60.42	44.50	18,383
29	.797	.577	22.84	21,618	25.70	61.00	43.30	17,640
30	.750	.536	21.64	21,114	25.36	55.97	39.90	14,773
31	.814	.520	21.68	18,446	23.51	47.80	36.00	16,356
32	.745	.534	22.18	14,859	23.25	48.40	36.70	19,612
33	.770	.598	22.94	16,271	24.64	53.73	39.20	16,561
34	.797	.528	23.11	18,301	24.74	53.87	40.00	15,736
35	.778	.590	22.37	19,899	22.29	47.63	39.70	10,349
36	.790	.545	20.10	23,036	21.27	44.60	36.70	17,087
37	.748	.558	20.21	22,156	22.37	52.50	38.00	15,577
38	.821	.560	20.20	30,482	22.64	42.40	38.20	19,254
39	.801	.498	19.69	38,868	21.90	47.60	38.00	17,194
40	.751	.576	19.66	33,605	20.87	43.40	36.80	15,888
41	.761	.519	18.96	34,683	20.29	42.00	35.40	17,054
42	.751	.493	18.72	38,338	20.36	43.30	36.60	16,810
43	.736	.476	18.91	35,558	20.48	42.00	36.00	17,807
44	.740	.537	19.03	42,915	20.18	43.10	37.80	16,883
45	.731	.502	18.98	45,825	21.12	43.90	38.60	16,962

Table II c. Data for the year 1954, continued.

Week	P_{r_c} ¢/lb.	P_{r_r} ¢/lb.	P_{f_p} $/cwt	Q_{f_p} head	P_{w_p} $/cwt	P_{w_l} $/cwt	P_{w_s} $/cwt	Q_{f_b} head
46	.739	.493	19.31	42,756	22.35	48.00	40.00	13,232
47	.744	.510	18.79	65,541	21.28	41.40	37.50	9,747
48	.727	.515	18.20	51,485	21.11	40.29	35.25	7,374
49	.753	.460	17.89	64,669	20.86	39.60	33.40	14,648
50	.674	.430	17.51	61,216	20.53	38.67	34.00	17,019
51	.674	.488	17.01	64,171	19.65	38.33	34.00	16,683
52	.735	.497	17.23	40,090	19.82	38.83	34.50	10,798
53	.715	.475	17.22	56,218	19.83	39.00	35.00	15,023

Table II d. Data for the year 1955.

Week	P_{r_c} ¢/lb.	P_{r_r} ¢/lb.	P_{f_p} $/cwt	Q_{f_p} head	P_{w_p} $/cwt	P_{w_l} $/cwt	P_{w_s} $/cwt	Q_{f_b} head
1	.692	.470	16.82	57,298	19.72	38.17	34.70	11,507
2	.659	.404	16.70	58,673	19.71	39.83	34.50	12,824
3	.659	.498	16.74	53,951	19.93	42.43	34.50	14,593
4	.629	.435	16.74	45,515	19.63	39.83	34.10	12,880
5	.673	.500	16.44	47,497	18.93	38.03	33.00	11,205
6	.688	.431	16.35	40,348	18.78	39.97	33.00	11,174
7	.690	.441	16.10	43,221	18.66	41.17	30.00	11,494
8	.717	.470	15.75	39,854	18.82	42.08	34.38	9,500
9	.680	.466	15.47	42,601	17.98	38.57	32.50	12,547
10	.641	.430	15.21	46,592	17.38	36.63	29.90	13,513
11	.681	.457	15.95	37,395	17.93	38.17	29.60	11,317
12	.706	.411	16.85	38,833	18.68	41.57	33.10	13,037
13	.676	.397	17.19	42,365	18.95	44.43	34.40	13,852
14	.705	.403	17.02	30,894	19.07	43.67	34.00	9,073
15	.730	.502	17.18	36,975	19.35	43.32	32.60	13,400
16	.704	.486	16.75	36,724	18.82	42.03	30.30	12,778
17	.699	.495	16.59	32,016	18.73	43.43	30.60	21,365
18	.703	.461	16.98	36,163	19.30	48.70	28.80	13,617
19	.751	.582	16.95	36,269	19.69	49.67	32.50	14,649
20	.762	.504	17.44	33,977	19.62	49.43	32.60	19,746
21	.750	.506	17.50	34,297	19.88	49.53	33.00	17,285
22	.744	.480	17.92	28.321	19.98	49.25	33.75	17,551
23	.765	.503	18.80	28,912	21.21	53.00	35.90	20,444
24	.808	.592	20.31	24,032	22.10	60.63	39.15	19,502
25	.819	.528	20.59	23,118	22.04	58.67	41.20	18,714

Table II d. Data for the year 1955, continued.

Week	P_{r_c} ¢/lb.	P_{r_r} ¢/lb.	P_{f_p} $/cwt	Q_{f_p} head	P_{w_p} $/cwt	P_{w_l} $/cwt	P_{w_s} $/cwt	Q_{f_b} head
26	.827	.601	19.70	21,073	20.69	48.40	39.70	16,035
27	.721	.554	18.64	20,714	20.58	47.75	39.12	13,702
28	.689	.477	18.37	21,114	20.25	48.65	39.10	13,318
29	.639	.464	17.20	19,024	19.12	43.60	33.40	13,924
30	.686	.429	16.86	19,127	18.38	41.43	31.65	14,539
31	.751	.503	15.82	15,841	18.17	39.97	31.20	12,280
32	.747	.463	16.29	19,170	18.90	41.30	31.90	16,167
33	.692	.469	16.56	24,658	19.25	45.20	32.20	12,332
34	.743	.472	16.46	24,175	18.37	46.28	31.75	11,812
35	.761	.483	16.19	25,465	18.03	43.90	31.95	15,248
36	.723	.454	16.37	22,971	18.65	48.67	33.00	13,892
37	.764	.483	16.35	32,447	18.63	48.53	34.10	17,997
38	.720	.506	16.16	31,904	18.43	42.78	34.25	16,992
39	.733	.452	15.90	33,592	17.56	41.67	33.15	16,310
40	.736	.456	15.38	43,758	17.35	42.10	33.50	17,825
41	.710	.438	14.94	41,753	16.97	39.63	32.35	19,718
42	.692	.504	14.33	48,459	16.51	38.08	29.45	16,552
43	.654	.425	13.59	58,141	15.88	35.02	26.55	18,776
44	.679	.421	13.56	65,811	16.35	38.12	28.55	16,506
45	.608	.426	13.15	59,461	16.27	35.35	28.31	16,573
46	.613	.392	12.01	78,811	15.72	33.07	28.05	18,786
47	.646	.443	11.26	53,540	15.42	32.06	26.50	13,305
48	.638	.445	10.98	82,940	15.23	31.82	24.80	16,286
49	.570	.484	10.72	73,434	14.73	31.17	24.50	18,146
50	.603	.422	10.57	77,747	14.58	30.57	24.40	15,762
51	.599	.375	10.73	49,074	14.17	27.45	24.45	15,368
52	.616	.452	11.06	57,082	14.63	31.17	24.50	13,245

Table II e. Data for the year 1956.

Week	P_{r_c} ¢/lb.	P_{r_r} ¢/lb.	P'_{f_p} $/cwt	Q_{f_p} head	P_{w_p} $/cwt	P_{w_l} $/cwt	P_{w_s} $/cwt	Q_{f_b} head
1	.589	.366	10.85	56,804	15.02	31.17	25.44	11,874
2	.594	.387	10.92	71,418	14.47	29.18	25.20	16,890
3	.574	.419	11.03	63,504	14.72	31.85	24.85	14,594
4	.600	.406	12.90	40,790	16.03	37.20	26.20	18,340
5	.667	.422	13.60	46,660	16.28	39.35	27.95	14,763

Table II e. Data for the year 1956, continued.

Week	P_{r_c} ¢/lb.	P_{r_r} ¢/lb.	P_{f_p} $/cwt	Q_{f_p} head	P_{w_p} $/cwt	P_{w_l} $/cwt	P_{w_s} $/cwt	Q_{f_b} head
6	.635	.422	12.56	47,296	15.40	33.03	27.80	14,295
7	.630	.408	12.02	41,921	15.39	34.18	27.30	16,943
8	.619	.400	11.74	37,714	15.59	33.77	27.00	16,445
9	.603	.391	11.91	44,946	15.26	31.78	26.75	16,657
10	.638	.410	11.99	42,906	15.25	31.62	25.10	13,926
11	.571	.351	12.53	34,900	15.24	32.90	24.30	16,336
12	.643	.357	13.72	32,200	16.03	37.08	26.90	17,431
13	.644	.438	14.55	31,881	16.64	38.13	29.90	12,039
14	.631	.430	15.24	30,583	17.20	39.83	29.35	15,827
15	.666	.453	15.02	34,768	16.70	37.97	28.50	17,224
16	.619	.410	14.98	35,860	16.99	40.75	28.25	18,351
17	.703	.493	15.22	40,343	17.55	43.51	28.80	17,827
18	.688	.496	15.16	31,581	17.22	40.75	28.85	21,007
19	.692	.457	15.29	27,338	17.34	40.30	28.05	15,831
20	.693	.459	16.77	25,497	18.51	46.80	30.00	14,971
21	.733	.509	17.67	26,351	19.07	48.92	33.55	19,320
22	.732	.515	17.36	25,767	19.57	52.97	37.42	15,595
23	.797	.577	17.27	28,860	19.09	48.55	38.35	24,518
24	.748	.501	16.84	23,458	18.89	44.35	35.40	23,015
25	.741	.520	15.94	20,127	18.06	38.63	33.75	18,508
26	.765	.420	16.42	21,071	18.39	41.18	33.00	18,570
27	.743	.516	16.49	21,561	18.65	46.72	33.00	21,547
28	.769	.497	16.30	22,692	18.13	46.63	32.75	20,141
29	.734	.482	16.38	20,948	18.48	47.83	33.75	19,817
30	.682	.513	16.58	18,374	18.19	46.63	33.55	13,818
31	.728	.490	16.82	21,048	18.46	46.28	32.80	18,047
32	.701	.480	16.78	19,318	18.35	44.45	32.00	18,219
33	.758	.508	16.91	18,759	18.41	43.83	32.55	16,568
34	.694	.396	17.07	18,669	18.52	46.88	35.50	14,658
35	.708	.545	16.58	24,192	18.03	44.90	36.00	19,218
36	.764	.556	16.27	28,309	18.82	48.60	36.50	12,306
37	.771	.544	15.92	31,307	18.20	45.73	35.30	16,688
38	.737	.490	16.21	31,264	18.62	47.83	34.55	15,401
39	.735	.551	16.83	29,754	18.96	49.03	35.80	18,179
40	.761	.513	16.33	26,514	17.89	42.73	34.80	16,820
41	.742	.550	16.05	35,310	17.64	44.15	34.85	15,296
42	.728	.487	16.04	36,114	18.19	44.08	35.15	17,429
43	.743	.508	15.60	45,354	17.25	40.95	33.30	18,332
44	.688	.436	14.61	39,745	16.90	37.13	30.10	14,934
45	.641	.444	14.93	43,847	17.08	38.65	30.15	12,655
46	.716	.404	14.45	47,243	17.12	36.25	28.50	18,038
47	.716	.485	14.93	28,046	17.62	35.50	29.06	16.660
48	.679	.424	15.48	46,414	17.87	35.50	29.15	15,034
49	.721	.460	16.11	40,187	18.25	37.05	29.15	18,572
50	.670	.451	16.97	41,280	18.57	36.38	30.65	18,594
51	.724	.415	16.89	37,280	18.92	38.45	33.40	14,795
52	.711	.433	17.36	30,734	19.56	43.00	34.92	19,135

Table II f. Data for the year 1957.

Week	P_{r_c} ¢/lb.	P_{r_r} ¢/lb.	P_{f_p} $/cwt	Q_{f_p} head	P_{w_p} $/cwt	P_{w_l} $/cwt	P_{w_s} $/cwt	Q_{f_b} head
1	.676	.495	17.10	35,169	19.25	38.94	34.50	16,104
2	.669	.445	17.19	43,567	19.32	39.23	34.40	18.890
3	.750	.475	18.12	37,886	20.67	44.45	36.45	22,361
4	.722	.507	18.34	36.224	20.52	43.00	36.00	17,674
5	.753	.484	18.25	35,989	20.73	44.03	36.00	18,650
6	.758	.529	17.59	34,630	20.15	42.23	36.20	13,766
7	.702	.458	16.94	31,678	19.74	41.93	34.70	17,077
8	.709	.444	16.90	24,371	19.71	40.94	33.19	17,573
9	.737	.527	16.88	29,703	19.49	41.05	33.05	16,397
10	.724	.480	16.68	30,132	19.44	40.20	33.20	15,748
11	.702	.487	17.29	25,593	19.64	40.85	33.06	14,986
12	.724	.508	17.46	27,002	19.84	40.69	32.44	15,386
13	.715	.439	17.78	31,624	20.04	42.35	33.22	16,809
14	.750	.467	17.83	25,535	19.88	40.53	34.44	18,170
15	.725	.492	18.02	28,281	20.39	43.82	39.38	19,410
16	.720	.519	18.17	22,240	20.36	43.06	36.50	14,938
17	.710	.523	17.95	30,000	20.25	42.60	35.31	17,544
18	.685	.457	17.93	26,822	20.11	41.31	34.00	13,645
19	.702	.477	17.99	28,172	20.43	43.72	34.38	22,852
20	.765	.535	17.74	27,977	20.63	46.06	35.50	23,594
21	.726	.546	18.11	28,936	20.36	44.66	35.00	20,352
22	.780	.500	19.06	16,993	20.96	46.34	35.17	13,386
23	.767	.533	19.85	29,378	22.05	52.72	36.00	15,858
24	.744	.529	19.15	24,078	22.23	53.66	38.50	18,093
25	.761	.519	19.36	19,963	21.17	43.44	35.00	19,757
26	.727	.465	19.50	20,058	21.27	42.62	33.75	15,024
27	.770	.600	19.72	11,482	21.65	44.63	33.92	18,224
28	.735	.538	20.38	20,847	22.84	50.69	38.25	19,930
29	.765	.593	21.07	19,010	23.48	51.69	40.75	19,069
30	.793	.519	21.38	15,831	23.09	46.38	38.12	17,928
31	.795	.501	22.14	16,503	23.27	47.28	37.50	17,560
32	.796	.593	21.90	17,596	23.68	50.56	39.12	21,897
33	.708	.545	21.29	19,703	23.03	47.69	39.69	21,060
34	.779	.543	20.52	21,330	22.67	47.30	39.44	19,936
35	.823	.555	21.20	19,992	22.42	49.50	39.25	18,977
36	.787	.555	21.09	20,048	22.69	51.63	39.83	18,317
37	.788	.550	20.21	27,084	21.76	49.06	40.62	21,267
38	.751	.538	18.89	29,078	20.74	47.03	38.00	20,914
39	.740	.508	17.91	26,861	19.35	45.48	35.12	16,071
40	.753	.558	18.37	28,179	19.72	47.53	36.38	19,892
41	.791	.504	17.60	31,016	19.55	47.19	36.50	18,248
42	.783	.530	17.25	39,193	19.68	46.22	37.21	15,543
43	.712	.485	17.02	39,955	18.97	43.82	36.50	19,907
44	.733	.570	16.77	35,634	18.63	42.72	34.31	22,397
45	.746	.482	16.77	41,136	19.17	43.16	33.50	17,041

Table II f. Data for the year 1957, continued.

Week	P_{r_c} ¢/lb.	P_{r_r} ¢/lb.	P_{f_p} $/cwt	Q_{f_p} head	P_{w_p} $/cwt	P_{w_l} $/cwt	P_{w_s} $/cwt	Q_{f_b} head
46	.721	.498	17.11	41,104	20.21	48.92	37.17	22,818
47	.728	.516	17.14	39,359	19.15	39.88	36.00	18,689
48	.732	.538	17.80	30,710	20.24	43.75	37.00	14,387
49	.741	.463	17.93	42,971	19.90	41.60	35.50	17,790
50	.776	.543	18.56	38,906	21.09	45.58	36.50	19,710
51	.762	.548	18.80	40,493	21.09	44.13	37.88	19,643
52	.727	.553	19.64	27,992	21.59	45.88	38.00	14,047

Table II g. Data for the year 1958.

Week	P_{r_c} ¢/lb.	P_{r_r} ¢/lb.	P_{f_p} $/cwt	Q_{f_p} head	P_{w_p} $/cwt	P_{w_l} $/cwt	P_{w_s} $/cwt	Q_{f_b} head
1	.747	.551	18.24	36,108	20.26	43.50	37.50	13,031
2	.718	.477	18.90	43,276	21.41	46.18	37.00	15,760
3	.751	.440	19.05	42,095	21.68	47.91	38.00	16,502
4	.782	.503	19.76	32,014	22.36	48.95	38.45	16,687
5	.752	.582	19.31	33,688	21.57	45.75	37.50	14,460
6	.718	.517	19.40	30,372	21.85	46.15	38.00	12,159
7	.741	.582	20.31	25,520	22.28	48.23	38.62	15,161
8	.762	.545	20.75	25,405	22.55	47.94	39.69	13,260
9	.764	.543	20.17	29,591	22.56	48.20	40.69	10,455
10	.753	.545	20.59	30,202	22.82	48.15	39.90	11,012
11	.796	.527	20.88	27,135	22.99	49.85	40.75	10,298
12	.793	.528	21.62	28,314	23.47	49.88	44.00	10,649
13	.809	.576	22.01	26,765	23.17	49.24	44.55	14,159
14	.792	.591	21.18	28,325	22.97	49.13	41.90	11,123
15	.802	.531	20.95	32,656	23.51	49.46	41.00	14,629
16	.783	.577	20.74	37,579	23.22	48.33	40.81	12,934
17	.800	.531	20.28	40,104	22.97	48.41	41.00	17,385
18	.765	.664	20.48	34,006	22.72	47.41	40.88	17,378
19	.768	.565	21.46	30,863	23.20	49.43	40.50	18,655
20	.792	.600	23.21	33,071	24.37	54.69	42.81	19,832
21	.813	.594	22.54	32,355	24.21	52.53	44.50	16,592
22	.803	.612	22.67	25,580	24.62	52.50	45.44	17,587
23	.845	.569	22.37	30,356	24.53	52.20	45.38	20,738
24	.833	.651	22.65	24,977	24.98	53.93	45.50	20,347
25	.829	.553	23.49	22,672	25.13	55.30	46.50	21,235

Table II g. Data for the year 1958, continued.

Week	P_{rc} ¢/lb.	P_{r_r} ¢/lb.	P_{f_p} $/cwt	Q_{f_p} head	P_{w_p} $/cwt	P_{wl} $/cwt	P_{w_s} $/cwt	Q_{f_b} head
26	.790	.689	23.84	23,710	24.98	53.37	46.38	20,403
27	.778	.639	24.32	15,542	25.43	55.16	46.81	17,706
28	.794	.643	23.74	21,366	25.01	53.50	47.00	19,257
29	.796	.626	22.49	20,551	24.49	50.83	47.50	23,278
30	.818	.656	23.02	16,672	24.49	50.17	46.88	19,513
31	.747	.581	22.86	20,949	25.10	51.88	46.88	22,603
32	.812	.614	22.87	22,363	24.72	49.75	46.69	22,062
33	.809	.607	22.26	21,856	24.01	47.75	44.35	21,674
34	.841	.548	20.53	23,614	22.31	45.10	40.75	23,133
35	.810	.578	19.68	22,787	21.64	48.28	38.12	23,640
36	.817	.532	20.06	21,780	21.93	51.59	38.33	19,952
37	.778	.559	20.39	28,325	22.94	54.19	39.81	21,267
38	.802	.582	20.66	29,231	22.60	51.85	41.94	24,423
39	.841	.563	20.90	32,453	22.22	52.48	42.60	22,207
40	.805	.537	19.62	33,275	21.02	48.35	39.19	20,982
41	.818	.588	19.64	33,211	21.33	50.35	38.75	23,840
42	.820	.590	19.08	34,831	21.26	50.19	39.44	24,682
43	.873	.664	18.95	41,196	20.99	49.53	38.20	27,636
44	.810	.564	18.66	39,463	20.79	47.82	36.62	21,810
45	.789	.515	18.72	42,828	21.28	47.48	36.75	25,123
46	.781	.556	18.81	46,970	21.39	47.94	37.25	27,651
47	.794	.602	17.89	39,858	20.53	42.66	35.25	20,627
48	.769	.530	18.57	29,550	20.90	44.51	34.25	19,276
49	.727	.480	18.05	43,378	20.36	42.13	33.50	17,363
50	.696	.487	18.21	43,472	20.66	45.87	35.38	20,761
51	.758	.554	18.20	39,107	20.47	43.19	38.62	18,141
52	.715	.627	18.70	25,830	20.53	44.88	35.75	14,664