AN ECONOMIC ANALYSIS OF THE SWINE INDUSTRY IN TAIWAN

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AN ECONOMIC ANALYSIS OF THE SWINE INDUSTRY IN TAIWAN

By

Ching-Yung Liu

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CHAPTER I

INTRODUCTION

Economic Importance of the Swine Industry in Taiwan

Hogs are an important agricultural product in Taiwan. The industry yields an annual gross product worth NT$5,578,941 thousand dollars ($139,473 thousand). Hogs accounted for 16.6 per cent of the total value of agricultural production in 1967, ranking second to rice (36.7%). Hog raising is spread widely over the island, with 651,362, or 79.6 per cent of the total farm households in 1968 engaged in this enterprise. Over 107.7 per cent of the total farm households raised hogs in 1957, while the lowest percentage since 1950, 74.2, was recorded in 1968.[1,2] Cash receipts from the sale of hogs averaged 33.7 per cent of total cash farm income, being the largest single source of

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[1]The number of households which raised hogs was 817,376 in 1957. It was larger than the total number of farm households (759,234) because many non-farm households raised hogs in that year.

[2]Taiwan Rural Economy (Taiwan: Provincial Food Bureau, 1951-1968).

cash income. Rice which accounted for 28.0 per cent of cash receipts, ranked second.[3]

Due to increased agricultural population pressure in Taiwan on small-scale farms, cash receipts from the sale of hogs will probably play an even more important role in the future. This is despite the fact that the industry in Taiwan is a sideline business, rather than a large-scale specialized business. Farmers raise hogs in order to utilize their surplus labor, and some farm by-products fed to hogs. In addition, farmers raise hogs in order to increase the fertility of the soil by using the manure.

The government launched an "Integrated Swine Production Program" in 1963 which included improvement in hog breeding and artificial insemination. Hog farmers are provided concentrated feeds, veterinary and marketing services, etc. The objectives include: (a) the improvement and modernization of the swine industry, and (b) changing it from a sideline operation to a commercial production. Although the objectives are far from being realized, greater use of concentrated feed has shortened the time required for young pigs to reach slaughter weights, has improved breeding programs (such as three-way cross pigs) and there is some indication that hog raising might shift to commercial production.

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[3] Taiwan Agricultural Census Report (Taiwan: Provincial Department of Agriculture and Forestry, 1960).

Information in regard to consumption of pork also provides evidence of its importance in Taiwan. Among all meats, pork is most commonly and widely consumed by all economic levels of the people in Taiwan. Expenditures for pork represented 16.2 per cent of total family living expense in 1960, ranking second only to rice (24.9%).[4] During the last eighteen years the GNP per capita grew at the rate of 6.7 per cent per annum.[5] During that same time the per capita consumption of pork increased from 8.78 to 19.61 kg. or an average increase of 6.8 per cent per year. Despite the fact that a slower rate of population growth than that for the past eighteen years is anticiapted[6] an increase in per capita income of 4.5 per cent per annum is anticipated by the government in its ten-year Economic Development Plan (covers 1965-1974).[7] Pork consumption is, therefore, expected to increase further.

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[4]The report of Urban Area household living consumption expenditure survey, Provincial Taiwan Bank, 1960.

[5]World Bank Atlas, 1969 (International Bank for Reconstruction and Development, 1969).

[6]Y. T. Chang, Population Growth and Food Production and Consumption in Taiwan (Taiwan: National Taiwan University, 1967), pp. 109-10.

[7]Wen-Fu Hsu, Demand Production of Agricultural Products Relative to Economic Development in Taiwan (Taiwan: National Taiwan University, 1967), p. 8.

Need for Study

From the foregoing description of recent and prospective developments in Taiwan, it is evident that hog raising is a very importnat item in farm income. It is important to the prosperity of the rural economy, to the national income, and is also importnat from the standpoint of nutrition and general welfare. Changing economic and technical conditions in hog production in Taiwan focus attention on the value of an economic study of this industry. It is therefore important that a careful analysis of the factors influencing production, price, and consumption, be made in order that such information might be available to the relevant public and private decision makers.

Objectives of the Study

The purpose of this study is to present an economic analysis of the production, consumption, and price of the swine industry in Taiwan. Some of the important factors relating to that industry will be examined in an attempt to delineate problems and make recommendation for possible solutions. More specifically, the major objectives of this study are:

1. To measure the time trend of changes in production, price, and consumption of pork resulting from changing economic and technical conditions.
2. To analyze the factors affecting production, price, and consumption of pork, resulting from

changing economic, technical, and institutional conditions.

3. To determine the structure of supply, demand, and price of swine, and to establish an economic model using regression analysis.
4. To analyze the prospects and implications of hog production, price, and consumption in Taiwan.

Methods and Procedures

The major methods applied in this study are analytical and interpretative. Statistical methods will be used to analyze and interpret the economic background and development of the swine industry, from the available data and material which have been provided by the Provincial Department of Agriculture and Forestry (PDAF), Council for International Economic Corporation and Development (CIECD), the Joint Commission on Rural Reconstruction (JCRR), Provincial Food Bureau (PFB), and other government and private agencies. Diagrammatic presentation and regression analysis will be used in an attempt to examine and explain certain economic relationships among the factors relating to production, price, and consumption of swine.

The study will be divided into six parts. The first part, or introduction, has portrayed the economic importance of the swine industry in Taiwan, the need for the study, the objectives and methods which will be used.

Chapters II, III, and IV will present analyses of the historical data and trends in production, consumption and price. Chapter V will be based on the analysis in the three preceding chapters and will be designed to develop a statistical model of the Taiwan swine industry. Finally, a brief summary and implication of the findings of this study will be presented.

CHAPTER II

A REVIEW OF THE HOG SUPPLY

This chapter will be mainly concerned with time series data, or historical variables of hog production and consumption in Taiwan. It will show how production and consumption of hogs in Taiwan have developed and are likely to develop in the future. Long-term trends in the demand for hogs are mostly determined by changes in population growth, national income, patterns of income distribution, and changes in consumption habits of the population. General development of agricultural productivity, changes in techniques of production and the like, are major determinants of supply. Generally, the buying decisions of consumers determine the demand for pork. Producers' decisions, on the other hand, determine how many hogs they will breed and feed which in turn determines the quantity of pork available to consumers. Decisions of both producers and consumers play an important part in setting pork prices and indirectly in determining hog production.

Trend of Hog Supply

The record of hog supplies in Taiwan is one of prolonged expansion except for 1959 and 1960, when the Great Flood of August, 1959, caused enormous damage to crops and livestock. During the past eighteen years the number of hogs available for slaughter, and the number of hogs slaughtered have steadily increased. As shown in Table 2-1, the number of hogs slaughtered was 1,173,926 head in 1951. The number increased to 3,528,859 head in 1968, or an increase of over 200 per cent during the period.

However, in terms of slaughter weight, the increase has been greater, having increased 289 per cent during the same period (Figure 2-1). On the other hand, the number of hogs at the end of each year had increased only 33 per cent.

This suggests gains in productivity which are attributable to the whole complex of advancements in hog production usually referred to under the caption of "new technology." These advancements embrace genetic improvements in breeding, protection from diseases, and better feeds and rations that shorten the time required for young pigs to reach slaughter weight. Effects of these advancements are seen in the increase in the slaughter rate from 60 per cent to 98 per cent during the 1951-1968 period. A more detailed discussion of these factors is in order.

If we assume that the hog supply trend is linear in nature and use the method of least squares to fit a trend

TABLE 2-1.--The supply of hogs in terms of the number at the end of each year, number slaughtered and slaughter weights, Taiwan, 1951-1968. (1951 = 100)

Year	Number at the End of Each Year		Number Slaughtered		Slaughter Weight	
	Head	Index	Head	Index	Metric Ton	Index
1951	2,261,866	100.00	1,173,926	100.00	82,881	100.00
1952	2,610,929	115.43	1,258,167	107.17	93,966	113.37
1953	2,819,764	124.66	1,632,482	139.06	126,417	152.53
1954	2,871,169	126.94	1,713,148	145.93	130,612	157.59
1955	2,799,369	123.76	1,770,957	150.86	138,135	166.66
1956	3,040,663	134.43	1,930,782	164.47	148,670	179.37
1957	3,511,349	155.24	2,085,488	177.66	171,010	206.33
1958	3,572,882	157.96	2,373,708	202.20	198,794	239.85
1959	3,263,633	144.29	2,255,411	192.12	192,123	231.80
1960	3,164,571	139.91	2,139,633	182.26	181,084	218.48
1961	3,105,476	137.29	2,429,503	206.95	204,866	247.18
1962	2,921,218	129.15	2,607,017	222.07	217,401	262.30
1963	2,676,051	118.31	2,564,174	218.42	211,932	255.70
1964	2,717,822	120.16	2,544,696	216.76	224,272	270.59
1965	2,935,503	129.78	2,694,925	229.56	241,412	291.27
1966	3,110,066	137.50	3,015,977	256.91	272,110	328.31
1967	3,002,670	132.75	3,439,764	293.01	314,627	379.61
1968	3,010,564	133.10	3,528,859	300.60	322,604	389.23

Source: Taiwan Agricultural Year Book (Taiwan: Provincial Department of Agriculture and Forestry, 1951-1968).

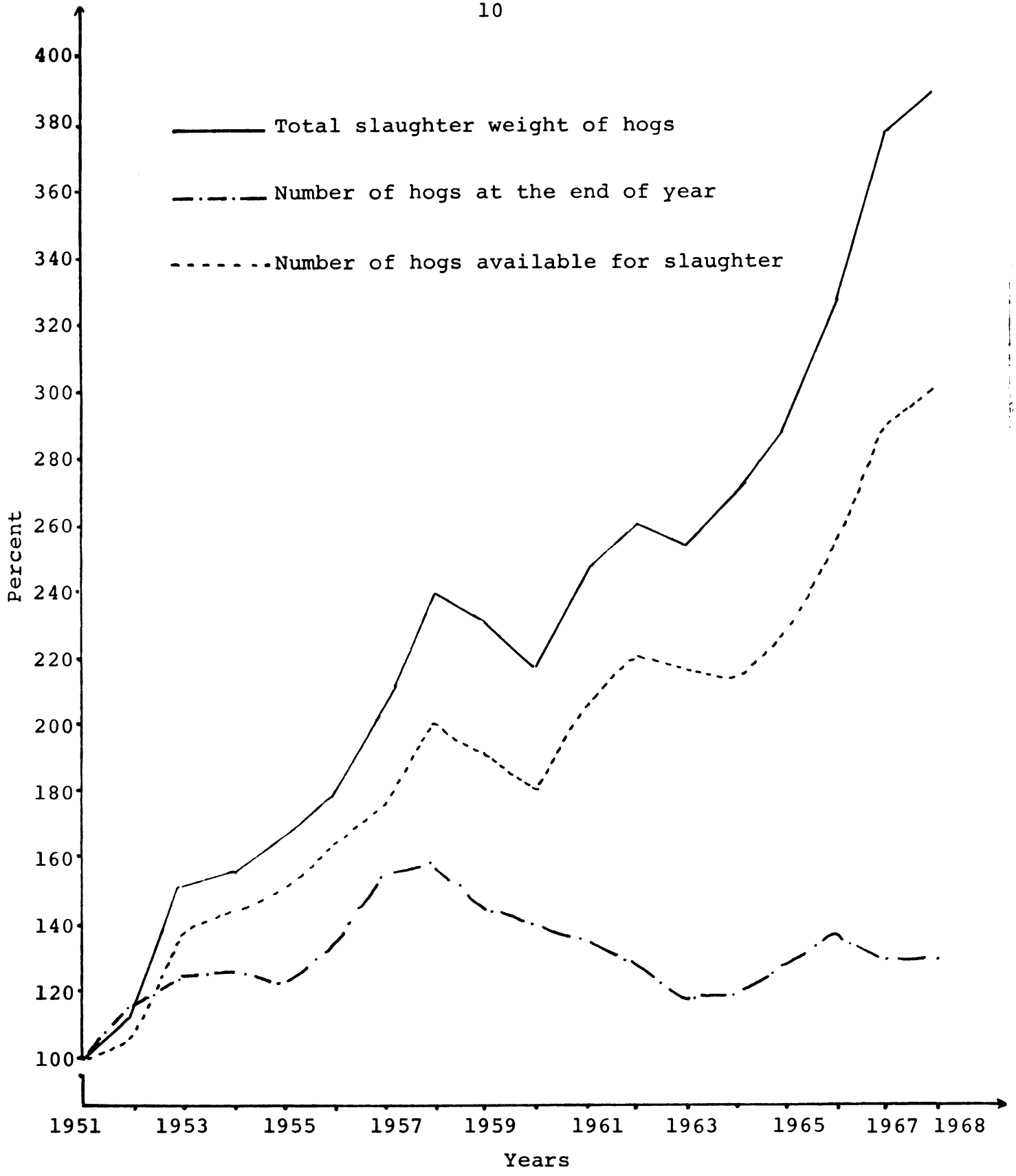

FIGURE 2-1.--Index of hog numbers available for slaughter, numbers at the end of each year, and slaughter weights, Taiwan, 1951-68.

line from the available time-series data of the number of hogs on hand at the end of each year (Nre), the number slaughtered (Ns), and the slaughter weights of hogs (Qs), we obtain three linear trend equations:

$$Nre = 2{,}815{,}955.19 + 15{,}838.43\ t \text{ (origin 1950)} \quad (1)$$

where

Nre is the number at the end of each year

t is time in year

$$Ns = 1{,}153{,}262.12 + 119{,}297.66\ t \text{ (origin 1950)} \quad (2)$$

where

Ns is the number of hogs slaughtered during the year

t is time in year

$$Qs = 75{,}732.14 + 12{,}337.67\ t \text{ (origin 1950)} \quad (3)$$

where

Qs represents the total slaughter weight of hogs during the year in metric tons

t is time in year

The coefficients of the variables for the above three equations are all positive. They represent the increasing supply of hogs in terms of the number at the end of each year, the number slaughtered, and the total weight of slaughter. As the change ratios are measured different rates of increase are noted. Equations 1, 2, and 3 equal 1.8 per cent, 11 per cent, and 16 per cent, respectively. Total slaughter weights showed the highest rate of increase

while the number at the end of each year showed only a slight increase. This suggests that the increased hog supply is attributable not only to the larger number of hogs available for slaughter, but also to the increase in slaughter weights per head. The average slaughter weight increased from seventy-one kilograms to ninety-one kilograms during 1951-1968.[1] It is important that explanations for the increase in number of hogs available for slaughter and for the increased slaughter weights be sought.

Factors Associated with Changes in the Hog Supply

The upward trends in total slaughter weight and the number of hogs available for slaughter probably resulted from several influencing factors. These include: an increase in demand, technological progress, favorable hog prices for farmers, prices of inputs, other influences such as government policies, the weather which affects the farfowing of pigs and sweet potato production. In the following paragraphs some of these factors will be examined.

Demand

It is axiomatic that the long-run growth record for any commodity is determined not only by secular trends in its demand but also by the capacity of production to fulfill

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[1] Taiwan Agricultural Yearbook (Taiwan: Taiwan Provincial Department of Agriculture and Forestry, 1951-1968).

whatever challenge demand sets for it. Emerging strength or weakness of demand is both a controlling force over production, and a standard by which its adequacy is measured.[2] There are many aspects about the changes in demand for pork. The most influential considerations are: population, national income, consumer's tastes and preferences, and the supply of competing meats. Price induced expansion and contraction of production is the result of the operation of demand and supply forces. Demand can be stimulated or discouraged over time by the efficiency with which the product is provided to satisfy it. With population increasing at the rate of about 3 per cent per year and incomes at about 4 per cent, these could be important sources of a stronger demand for pork. They will be discussed in greater detail in the later analysis.

Technology

The supply functions can change as a result of technological progress. Improved technology will shift the supply curve to the right and has probably played a major role in the larger supply of hogs in Taiwan.

Increase in crossbred hogs produced.--One evidence of technological progress in hog raising is the increase of

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[2]Harold F. Breimyer, Demand and Prices for Meat--Factors Influencing Their Historical Development, Technical Bulletin No. 1253 (Washington, D.C.: United States Department of Agriculture, 1961), pp. 29-30.

crossbred hogs. Three breeds are grown in Taiwan. These are native hogs, western hogs, and crossbred hogs. The native hogs have the advantage of high adaptability to the use of roughages, but about fourteen or sixteen months time is required for young pigs to reach slaughter weight. The western hogs which are imported for breeding include: Berkshire and Yorkshire from England, and Hampshire, Duroc Jersey, and American Landrace from the United States. All of those hogs have the characteristic of rapid growth rates and high feed efficiency, but the pigs have a high mortality in Taiwan.

The improved hog is a crossbreed from the native and western hogs. Crossbred pigs have greater efficiency in use of feeds, high protection from disease, and can use rations which shorten by four to six months the time required for young pigs to reach slaughter weights.

The percentage of native hogs decreased from 14 per cent to 2.87 per cent in the 1951-1968 period, and crossbred hogs increased from 85 per cent to 96.3 per cent in the same period (Table 2-2). This increase has played a major role in the increased number of hogs available for slaughter.

Disease control.--Disease control is another important factor in the increased hog supply. Taiwan is located in subtropical area and there are many disease problems.

TABLE 2-2.--The number and percentage of hog breeds in Taiwan, 1951-1968.

Year	Total Number of Hogs Raised in the Year*	Native Hogs		Western Hogs		Crossbred Hogs	
		Head	Per Cent	Head	Per Cent	Head	Per Cent
1951	3,556,682	501,273	14.09	7,824	0.22	3,047,585	85.69
1952	4,341,478	577,325	13.30	14,125	0.32	3,750,028	86.38
1953	4,621,590	563,183	12.19	23,293	0.50	4,035,114	83.71
1954	4,869,969	549,837	11.29	21,705	0.45	4,298,427	89.26
1955	4,953,128	352,407	7.11	29,226	0.59	4,571,495	92.30
1956	5,066,771	361,713	7.14	28,686	0.58	4,676,372	92.28
1957	5,515,419	407,573	7.39	29,749	0.54	5,078,097	92.07
1958	6,038,799	414,367	6.86	29,955	0.50	5,594,477	92.64
1959	5,961,081	390,639	6.55	28,245	0.48	5,542,197	92.97
1960	5,632,818	332,131	5.90	22,737	0.40	5,277,950	93.70
1961	5,596,864	330,025	5.90	18,702	0.33	5,248,137	93.77
1962	5,342,063	271,820	5.09	19,960	0.37	5,050,283	94.54
1963	5,279,029	228,688	4.33	16,277	0.31	5,034,064	95.36
1964	5,320,246	194,410	3.66	12,656	0.24	5,113,180	96.10
1965	5,700,826	212,188	3.73	17,973	0.32	5,470,665	95.95
1966	6,219,680	230,144	3.70	29,670	0.48	5,959,866	95.82
1967	6,521,649	222,751	3.41	38,607	0.59	6,260,291	96.00
1968	6,605,172	189,347	2.87	57,480	0.87	6,358,345	96.26

*Total number of hogs raised in the year is equal to the number born plus the number at the end of last year.

Source: Compiled from Taiwan Agricultural Year Book (Taiwan: Provincial Department of Agriculture and Forestry, 1951-1968).

The figures in Table 2-3 indicate that hog cholera once was a deadly enemy to swine production in Taiwan. Before 1955 the number of hogs which died from cholera was in the thousands. Since 1955 a strain of lapinized hog cholera virus was introduced from the Philippines and has been widely used for hog vaccination. The number of hogs dying from cholera rapidly decreased until in 1968 there were only 661 head. Similarly, the number of hogs dying from Erysipelas was reduced from 8,785 head in 1951 to 737 head in 1968.

Due largely to the effective control of hog cholera and erysipelas, hog mortality caused by contagious diseases has declined from 3.14 per cent to 0.14 per cent during the period 1952-1968.

Another important factor which has contributed to hog disease control is livestock insurance by Farmer's Associations. This service was designed to strengthen the control of livestock diseases (hogs are the most important livestock) and also to protect the interest of livestock husbandmen. This reduced risk and uncertainty and tended to foster increase of numbers available for slaughter.

Higher Farm Prices of Hogs

Even though farmers are price takers and not in a position to influence prices in the short-run, they will respond to the level of prices they receive and adjust their production accordingly. If the prices are favorable more

TABLE 2-3.--The number of hogs dying from contagious diseases, Taiwan, 1951-1968.

Year	Mortality Rate* %	Total Number Dying of Contagious Diseases (Head)	Hog Cholera (Head)	Pasteur-ellosis (Head)	Erysipelas (Head)
1951	22.08	25,927	14,490	2,652	8,785
1952	31.49	39,629	25,189	7,119	7,321
1953	15.39	25,137	18,940	3,210	2,987
1954	10.69	18,314	13,625	2,210	2,479
1955	12.11	21,449	16,516	2,526	2,407
1956	7.00	13,519	7,569	3,458	2,492
1957	4.96	10,352	5,116	2,957	2,279
1958	2.92	6,945	1,680	3,117	2,148
1959	2.97	6,700	532	3,861	2,307
1960	3.11	6,662	646	3,833	2,183
1961	3.24	7,891	1,193	4,424	2,274
1962	3.57	9,305	1,297	5,678	2,330
1963	3.08	7,914	1,204	4,562	2,148
1964	2.45	6,234	699	3,809	1,726
1965	2.19	5,908	355	4,455	1,098
1966	1.86	5,617	637	4,045	935
1967	1.97	6,785	1,023	3,872	867
1968	1.49	5,254	661	3,856	737

$$*\text{Mortality rate} = \frac{\text{the total number dying from contagious diseases}}{\text{total number slaughtered}} \times 1{,}000.$$

Source: Compiled from data in Taiwan Agriculture Year Book (Taiwan: Taiwan Provincial Department of Agriculture and Forestry, 1951-1968).

would be subsequently raised for sale. In addition new producers would start raising hogs. If prices are low, farmers tend to reduce the number produced and some farmers will withdraw from this enterprise. Owing to the fluctuation of the prices of hogs and feedstuffs, the number of farm households which raised hogs varied considerably during the last eighteen years. The peak was 817,376 households recorded in 1957, and the trough was 651,362 which occurred in 1968.[3] In order to see the responsiveness of farmers to change in hog prices in Taiwan, studies were carried out which indicated that farmers respond to favorable prices, provided proper opportunities are given. Lu calculated the elasticity of supply with respect to price at 0.47 for the number of hogs slaughtered and 0.53 for total slaughter weight.[4] Mao calculated the correlation coefficient between hog numbers at tne end of each year and hog prices as being 0.98.[5] The index of hog prices and the number of hogs supplied for slaughter are shown in Figure 2-2. A more intensive examination of hog prices is reserved for Chapter IV.

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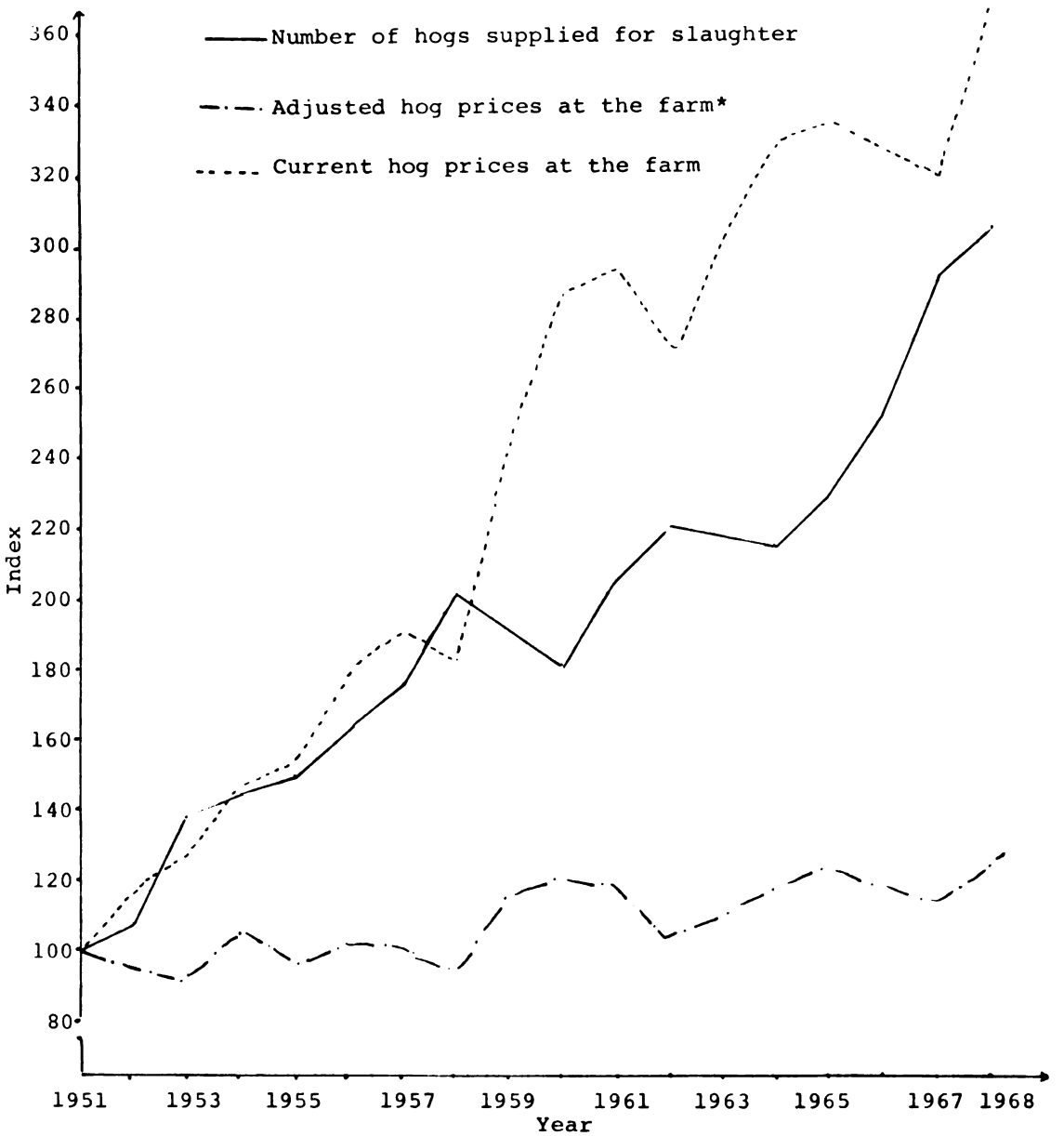
[3]Taiwan Provincial Food Bureau Year Report, 1952-1968.

[4]Ming-Hue Lu, "A Study of Supply, Demand and Price of Hog in Taiwan," Journal of Agricultural Economics, No. 7 (1969), 64.

[5]Y. K. Mao, A Study of Hog Production in Taiwan (China Food Economics Association, 1968), p. 16.



*The current price adjusted with the index numbers of wholesale price in Taipei.

Source: For index of number of hog supplied for slaughter, see Table 2-1 for data. For index of hog prices, see Table 4-1 for data.

FIGURE 2-2.--Index of adjusted and current hog prices and number of hogs supplied for slaughter in Taiwan, 1951-1968.

Prices of Inputs

Production costs are an important item which affect profits from producing a product. Prices of feedstuff and feeder pigs are the most important items of production cost.

According to Hsu's survey,[6] the total cost of feed to grow a young pig to a hundred kilograms for sale was NT$1,397. The feedstuff items and the percentage of each item in the ration are shown in Table 2-4.

TABLE 2-4.--The cost of feedstuff to produce a hundred kilograms of hogs in Taiwan, 1965.

Feedstuff Cost Elements	Expense (NT$)*	Percent of Total Cost of Feedstuffs
Sweet potato	311	22
Sweet potato chop	145	10
Sweet potato vine	216	15
Cassava chop	78	6
Soybean meal	171	12
Rice bran	164	12
Wheat bran	54	4
Fodders of composition of ration	134	10
Surplus meal	40	3
Others	84	6
Total	NT$1,397	100

*A U. S. dollar is equal to forty NT dollars.

Source: Wen-Fu Hsu, "The Cost Survey of Hogs Raised in Taiwan," Journal of Taiwan Bank, XIX (1967), 253-54.

[6]Wen-Fu Hsu, "A Cost Survey of Hogs Raised in Taiwan," Journal of Taiwan Bank, XIX (1967), 253-54.

Hog production in Taiwan is largely dependent upon a single feed crop--sweet potatoes, much the same as with corn in the United States. Although some mill feeds are used, sweet potatoes are the main hog feed. Sweet potato prices therefore, provide a measuring stick to determine the farmer's costs to feed his hogs. The area planted to sweet potatoes in Taiwan has decreased slightly year by year since 1955, due to the government policy of promoting rice production. At the same time, the per hectare yield of sweet potatoes for the last fifteen years has increased only 4 per cent.[7] Because the production of sweet potato has lagged behind the demand growth, the price of sweet potatoes has tended upward. The equation used to compute price tends of sweet potato chops is:

$$(P_s) = 67.77 + 11.80\ t \text{ (origin 1950)} \qquad (4)$$

where

P_s is the deflated price of sweet potato chop (NT$/100 kg)

t is time in year

Another important item of production cost is the feeder pig. Only a small portion of Taiwanese farmers have their own brood sows, so most purchase pigs from outside. The average cost was NT$437 per pig in 1965, about one-fifth

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[7]Yen-Tien Chang, Population Growth and Food Production and Consumption in Taiwan (Taiwan: National Taiwan University, 1967), pp. 49-50.

the total production cost.[8] The pig prices trend equation follows:

$$P_g = 976.18 + 122.42\ t \text{ (origin 1950)} \qquad (5)$$

where

P_g represents the deflated pigs price (NT$/100 kg)

t is time in year

Both equations 4 and 5 indicate that the price of the most important input, sweet potato chops, and of pigs prices, are trending upward.

In addition there are non-price factors which seem to be important in hog raising according to Hsu's study. These include: the farm size, farm labor, capacity of pig sty, etc. Hsu's cost survey study gave evidence that even though hog raising is not profitable, almost all farmers (98%) would still like to raise hogs.[9]

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[8]Hsu, A Cost Survey of Hogs Raised in Taiwan, p. 248.

[9]Ibid., p. 258.

CHAPTER III

A REVIEW OF HOG DEMAND

The area of consumption in the present economy is very important. In Taiwan meat is of vital account in the daily necessities, and pork is the meat which is most commonly and widely consumed. In this chapter time series data on pork consumption will be used to analyze the changes in demand over time, and an effort will be made to identify the factors affecting the demand for pork.

Trend of Pork Demand

As stated before, pork is by far the most important food of animal origin in Taiwan. It provides the most important animal fat and protein in Taiwan. This is due mainly to the relatively low price of pork in comparison with other meat products. This low price turn is ascribed to the strong and stable supply of pork from almost every farm family. Taiwan is almost self-sufficient in hog production, although before 1957 a relatively small amount was imported from neighboring countries. Small amounts have

been exported to neighboring countries since 1960.[1] Since data regarding pork imports and exports being not available, therefore it is assumed that all hogs produced in Taiwan were consumed in the domestic market.

Total pork consumption in Taiwan can be obtained by multiplying the live weight by 83 per cent of all hogs to be slaughtered. From the data in Table 3-1 it is noted that total pork consumption was 68,791 metric tons in 1951 and increasing 267,761 metric tons in 1968 for an increase of 289.24 per cent in the eighteen year period. Total consumption steadily increased except for the years 1959 and 1960 when, after the Great Flood of August 1959, the government promulgated a decree prohibiting the slaughter of hogs on Tuesday and Friday during 1959-1960. A simple trend equation from the available time series data is as follows:

$$Q_p = 62,875.66 + 10,240.28\ t \text{ (origin 1950)} \qquad (6)$$

where

Q_p = total pork consumption in metric tons

t = time in year

The positive sign indicates that total pork consumption increased during the period. The increase averaged 10,240 metric tons or about 16 per cent per annum.[2]

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[1] Pe-Kung Yen, "Pork Consumption and International Trade," Journal of Taiwan Bank, XVII (1966), 166-67.

[2] Total consumption increased 16 per cent. Per capita consumption increased almost 7 per cent. For remainder, 9 per cent should represent population increase. Population, however, increased 4 per cent. The reason for the discrepancy is not readily apparent.

TABLE 3-1.--Total consumption and per capita consumption of pork in Taiwan, 1951-1968. (1951 = 100)

Year	Total Consumption*		Per Capita Consumption	
	Quantity (Metric Tons)	Index	Quantity (Kilograms)	Index
1951	68,791	100.00	8.78	100.00
1952	77,991	113.74	9.57	108.99
1953	104,926	152.53	12.38	141.00
1954	108,408	157.59	12.39	141.11
1955	114,652	166.67	12.48	142.14
1956	123,396	179.38	12.91	147.04
1957	141,938	206.33	14.46	164.69
1958	165,002	239.86	15.92	181.32
1959	159,462	231.80	14.70	167.42
1960	150,299	218.48	13.92	158.54
1961	170,039	247.18	15.25	173.69
1962	180,442	262.30	15.67	178.47
1963	172,903	251.34	14.80	168.56
1964	186,146	270.59	15.19	173.00
1965	200,372	291.37	15.87	180.75
1966	225,851	328.31	17.38	197.95
1967	261,140	379.61	19.64	223.69
1968	267,761	389.24	19.61	223.35

Source: Taiwan Agricultural Yearbook (Taiwan: Provincial Department of Agriculture and Forestry, 1951-1968).

*Total consumption was obtained by multiplying total slaughter weight by 83 per cent.

The increase was associated with: (1) population growth, (2) national income growth, (3) changes in prices of substitute meats, and (4) change of consumers preferences and taste. Among all of these factors, population growth is the most important. Data in Table 3-1 and Figure 3-1 show the change in per capita consumption and eliminate the influence of population changes.

Per capita consumption increased less rapidly than total consumption during the 1951-1968 period. The simple linear equation was:

$$\left(\frac{Q_p}{N}\right) = 9.79 + 0.49\ t \text{ (origin 1950)} \qquad (7)$$

where

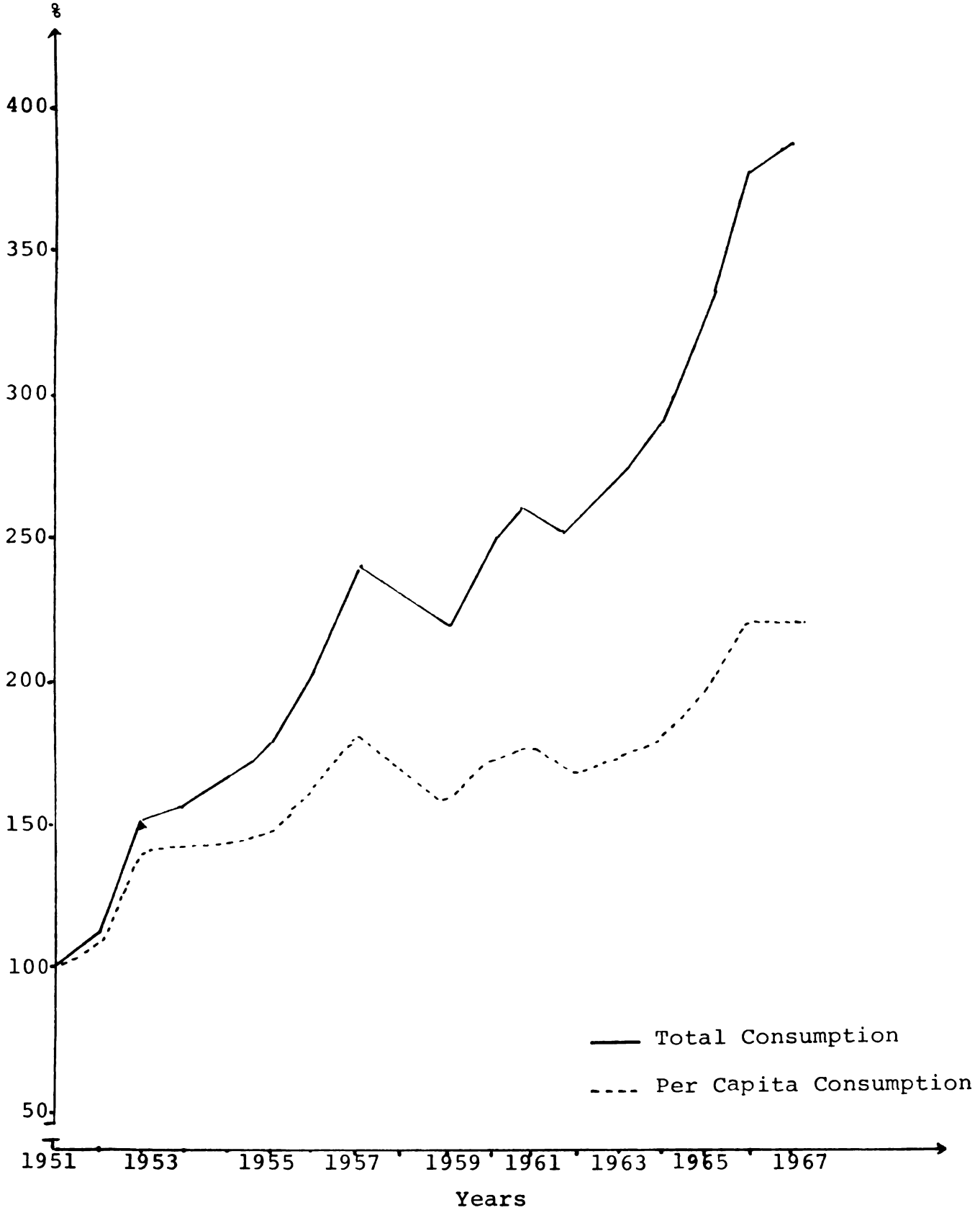
$\left(\frac{Q_p}{N}\right)$ = per capita consumption in kilograms

t = time in year

Per capita consumption of pork increased 0.49 kilograms per year at an average increase of about 6.8 per cent during the 1951-1968 period.

Factors Affecting Changes in Demand

Economic literature is replete with discussions of factors which may affect the demand for agricultural products such as pork. Among these may be: population, national income, price of pork and price of competing (other meats and fish) products, and consumers' tastes and preference. The upward trend of demand for pork in Taiwan was



Source: Taiwan Agricultural Yearbook (Taiwan: Provincial Department of Agriculture and Forestry, 1951-1968).

FIGURE 3-1.--Index of total consumption and per capita consumption for pork in Taiwan, 1951-1968. (1951 = 100)

affected by most of these factors but especially population growth and increases in income.

Population Growth

Population growth has had a much greater affect than growth in per capita income on the demand for agricultural commodities in rapid population growing countries such as Taiwan.[3] This is so because a 10 per cent increase in population would result in a 10 per cent increase in demand. Taiwan is one of the rapid population growth countries in the world. The population was 7.87 million persons in 1951 and 13.65 million persons in 1968, an average annual rate of increase of 3.2 per cent.[4]

It was stated before that total consumption increased 16 per cent per annum and per capita consumption increased only 6.8 per cent. This indicates about 60 per cent of the increased demand for pork was associated with the population growth.

Projections made by the Taiwan Population Studies Center in 1965 for the coming twenty-five years at two different rates of fertility--a high rate of fertility (without family planning) and a low rate of fertility (with family planning)--are shown in Table 3-2.

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[3]Hsu, Demand Projections of Agricultural Products Relative to Economic Development in Taiwan, p. 6.

[4]Compiled from data obtained from Taiwan Statistical Data Book (Execute Yuan, Republic of China: Council for International Economic Cooperation and Development, 1966-68).

TABLE 3-2.--Population projection in Taiwan for the coming twenty-five years.

Year	With Family Planning		Without Family Planning	
	Population	Annual Growth Rate	Population	Annual Growth Rate
1965	12,642,552	--	12,642,552	--
1970	14,311,756	2.64	14,463,205	2.88
1975	15,921,361	2.25	16,519,099	2.84
1980	17,584,299	2.08	19,015,526	3.02
1985	19,173,296	1.81	21,847,555	2.97
1990	20,485,182	1.37	24,825,986	2.72

Source: Taiwan Population Studies Center.

According to these projections, the low rate of fertility has a high probability because the natural increase in population has dropped already from 3.8 per cent in 1953 to 2.7 per cent in 1968. It is believed, therefore, that the growth rate with family planning is most likely. Despite the declining rate of growth, the total absolute population continues to increase. Thus, increased demand for pork is expected, but at a slower rate than for the past eighteen years.

In addition to population growth there are certain population characteristics which influence meat consumption. These are: occupation, family composition, religion,[5] and distribution of population in urban or rural areas.[6] Even though no data are available in regard to these factors for Taiwan, it is the writer's belief that they are relevant.

Growth of Income

Data in regard to the First Four-Year Economic Development Plan (1953-1956) indicate that GNP at 1964 constant prices increased from NT$40,698 million to NT$54,189 million between 1952 and 1956, or an average annual growth rate of 7.4 per cent. In the Second Four-Year Plan Period

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[5]"Meat Consumption Trends and Patterns," Agricultural Handbook 187 (Washington, D.C.: United States Department of Agriculture, 1960), pp. 20-22.

[6]Breimyer, Demand and Prices for Meat--Factors Influencing their Historical Development, pp. 19-25.

(1957-1960) real GNP rose to NT$77,177 million, and an average growth rate of 7.1 per cent per annum was recorded. During the Third Four-Year Plan Period (1961-1964) real GNP increased further to NT$102,492 million with an average annual growth rate of 9.6 per cent. The growth rate during the Fourth Four-Year Plan Period (1965-1968) averaged 10.5 per cent per year between 1965 and 1967.[7] Based on the above data it is clear that Taiwan has been experiencing rapid economic growth since the early 1950s. The government in its ten-year development plan covering 1965-1974 has anticipated a growth rate of 7 per cent per annum with the aggregate national income at 1964 prices estimated at NT$186,010 million and NT$260,888 million in 1975 and 1980, respectively.[8]

To eliminate the effect of population growth, national income based on per capita income was analyzed and the details are shown in Table 3-3. The growth rate of per capita income is less than the growth rate of national income. The average growth in per capita income in the 1951-1968 period was 4.6 per cent and the national income average growth rate was 7.9 per cent per year. The difference was caused by the population growth.

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[7] Te-Tsui Chang, Long-Term Projections of Supply, Demand, and Trade for Selected Agricultural Products in Taiwan (Taiwan: National Taiwan University, 1969), pp. 22-23. (Mimeographed)

[8] Ibid., p. 9.

TABLE 3-3.--Per capita income in Taiwan, 1951-1968.

Year	National Income		Per Capita Income	
	Amount (NT$ million)	Growth Rate	Amount (NT$)	Growth Rate
1951	29,336	--	3,728	--
1952	34,307	9.3	4,017	7.8
1953	36,572	6.6	4,146	3.2
1954	38,312	4.8	4,194	1.4
1955	41,801	9.1	4,409	5.1
1956	43,709	4.6	4,450	0.9
1957	46,814	7.1	4,620	3.8
1958	49,185	5.1	4,702	1.8
1959	52,963	7.7	4,901	4.2
1960	56,148	6.0	5,033	2.7
1961	60,779	8.2	5,281	4.9
1962	64,324	5.8	5,419	2.6
1963	72,356	12.5	5,913	9.1
1964	84,686	17.0	6,716	13.6
1965	89,613	5.8	6,903	2.8
1966	96,661	7.9	7,241	4.9
1967	105,528	9.2	7,712	6.5
1968	115,837	9.8	8,271	7.3

Source: Taiwan Statistical Data Book (Execute Yuan, Republic of China: Council for International Economic Cooperation and Development, 1966-1968), pp. 12-13.

At 1964 prices, adjusted for gain or loss due to change terms of trade, we get a linear trend equation:

$$I = 3219.69 + 261.81\ t \quad \text{(origin 1950)} \qquad (8)$$

where

I is per capita real income adjusted with the gain or loss due to the change in terms of trade at 1964 constant price (NT$)

t is time in year

Changes in per capita income influence the consumption patterns. This relationship is measured by the concept of income elasticity. Many researchers have conducted studies to measure the income elasticity of pork in Taiwan. Hsu[9] derived an income elasticity from the semi-log arithmatic function of 0.403. Mao calculated the income elasticity from time series data of pork of 0.53,[10] and Hsia gave a figure of 0.33.[11] Even though different income elasticities were all derived, all had positive signs. This indicates that per capita consumption of pork is positively responsive to changes in income.

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[9]Hsu, Demand Production of Agricultural Products Relative to Economic Development in Taiwan, p. 47.

[10]Mao, A Study of Hog Production, p. 23.

[11]Hun-Jung Hsia, "A Demand Analysis of Hog in Taiwan," Journal of Agricultural Economics, No. 2 (Taiwan: Taiwan Provincial Chung Hsing University, 1963), p. 146.

Changes in Pork Prices

When prices go up, the demand for pork declines. The reverse could happen if the price decreases. Changes in quantity demanded due to changes in price can be measured by price elasticity. Hsia calculated the price elasticity for pork in the 1950-1959 period at 1.45.[12] The high elasticity shows that demand for pork can be expanded very much if the price is reduced. If the pork price is reduced by one per cent the demand would increase by 1.45 per cent.

The data in Table 5-2 shows that pork prices fluctuated but trended slightly upward during the 1951-1968 period. It was NT$ 15.8 per kg. in 1951 and increased to NT$ 22.3 kg. in 1968, an increase of 41 per cent in the last eighteen years, or an average annual increase of about 2.2 per cent.

There was an increase of pork consumption that took place at a time when pork prices were increasing. This may be contrary to what might be expected. Apparently, the quantity of meat people consume today is still far below the saturation point, and pork provides the most important kind of meat to all levels of people in Taiwan. In the meantime the increase in pork prices are less than those for beef. The average increase rate in beef prices being about 7.4 per cent per year.

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[12] Ibid., p. 128.

The linear trend equation of pork prices is as follows:

$$P_p = 15.47 + 0.27\ t$$

where

P_p = the deflated pork price (NT$)

t is time

Prices and Quantities of Substitute Meats

In addition to population growth, increase in per capita income and the slight change in pork prices. Consumer's preferences and the price of substitute goods are also factors affecting the demand for a commodity. When the price of one food product becomes relatively cheaper most people tend to substitute it for other foods, to some extent. Commodities which may be substituted for pork are: beef, lamb, chicken, and fish (see Table 5-2).

The per capita consumption of beef in Taiwan was only 0.65 kg. in 1968. This extremely low production and consumption of beef is probably due to lack of pasture land and to certain religious taboos in Taiwan.

The quantity of mutton consumed is still smaller, with only 1,018 metric tons or 0.07 kilograms per capita,[13] being consumed in 1968. Since it is a food stuff for very few people, and since it is consumed only in winter, it can

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[13]Compiled from Taiwan Agricultural Year Book, p. 251.

be considered unimportant with respect to the total production and consumption of meat in Taiwan.

Other meats which compete with pork are chicken and fish, even though neither is as readily substitutable as is beef and lamb. Chicken in Taiwan is considered a relatively high-valued or high-priced product compared with most other animal products. The per capita consumption of chicken was 2.05 kilograms per year in 1951 and 3.03 kilograms by 1968. Even though the per capita consumption is still small, the trend is upward. It is generally believed that this is due to the improvement of breeds and better feeding techniques, thus reducing the time required for raising a chicken to marketing weight. Along with production increase and lower relative prices, chickens have become relatively inexpensive as compared with other meats. The price of chicken was NT$ 19.2 per kilogram in 1951 and NT$ 22.4 per kilogram in 1968. Thus, the price of chicken was only slightly higher in the trend than the price of pork and beef. So it is considered that chicken will become more important as a competitor to pork consumption in Taiwan. The trend linear equation of per capita consumption of chicken is:

$$\left(\frac{Q_C}{N}\right) = 1.92 + 0.04\ t \text{ (origin 1950)} \qquad (9)$$

where

$\left(\frac{Q_C}{N}\right)$ = per capita consumption for chicken in kilograms

t = time in year

$$P_C = 20.73 + 0.23\ t \text{ (origin 1950)} \qquad (10)$$

where

P_C = the deflated price of chicken (NT$/Kg)

t = time in year

Both trend equations showed that production increased about 2 per cent and the deflated price of chicken went up about one per cent per year.

Another competing commodity for pork is fish. It is a popular food and an important source of protein in the diet. Hsia computed the rate of substitution of fish for pork at 0.42.[14] Therefore, the price of fish and the fish supplied will affect the demand of pork. Per capita consumption of fish has showed an increasing trend from 13.34 kilograms to 34.91 kolograms in the period 1951-1968. The average growth rate of per capita consumption was 5.5 per cent per annum. The linear trend equation is:

$$\left(\frac{Q_f}{N}\right) = 12.91 + 1.17\ t \text{ (origin 1950)} \qquad (11)$$

where

$\left(\frac{Q_f}{N}\right)$ = per capita consumption (Kg)

t = time in year

The available data show that the deflated price of fish has fluctuated from year to year, but has trended

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[14] Hsia, A Demand Analysis of Hog in Taiwan, p. 152.

downward. This may be because of the abundant supply of fish in Taiwan. The linear equation of price of fish is as follows:

$$P_f = 8.23 - 0.01\ t \text{ (origin 1950)} \qquad (12)$$

where

P_f = the deflated price of fish per kilogram in NT$

t = time in year

In the previous sections it was suggested that the upward trend in aggregated consumption of pork was associated with the growth of population, national income, changes in pork prices, and other relevant factors such as consumer preference and the prices and quantities of substitute commodities. Among all of those factors, population growth is most important. The increase in national income is next and the changes in hog prices and the price of competing meats is the least important.

CHAPTER IV

TIME SERIES ANALYSIS OF HOG PRICES

In this chapter, an attempt will be made to describe and analyze the long-time movement and variations in prices received by producers on an inter-year and intra-year basis and attempt to determine the relationship, if any, between cycles of prices and production.

Secular Trend

Many statistical series show rising or falling trends over a period of time. If this period is for a decade or so, the change over time is called a secular trend. Such a trend is frequently found in population, production, and prices. Economics literature has pointed out that a very important method of classifying price-making forces has been called "Supply and Demand," price representing an interaction of the supply and demand factors in the market. So we can conclude that price movements are associated with changes in supply and in demand. When demand for the product moves to the right more rapidly than the supply, the price will show a trend upward. If the supply curve moves to the right more rapidly than the demand curve, the price

will tend to move downward. In addition, to the extent of the changes in the supply and demand, inflation or deflation of currency is another factor affecting long-time price movements.

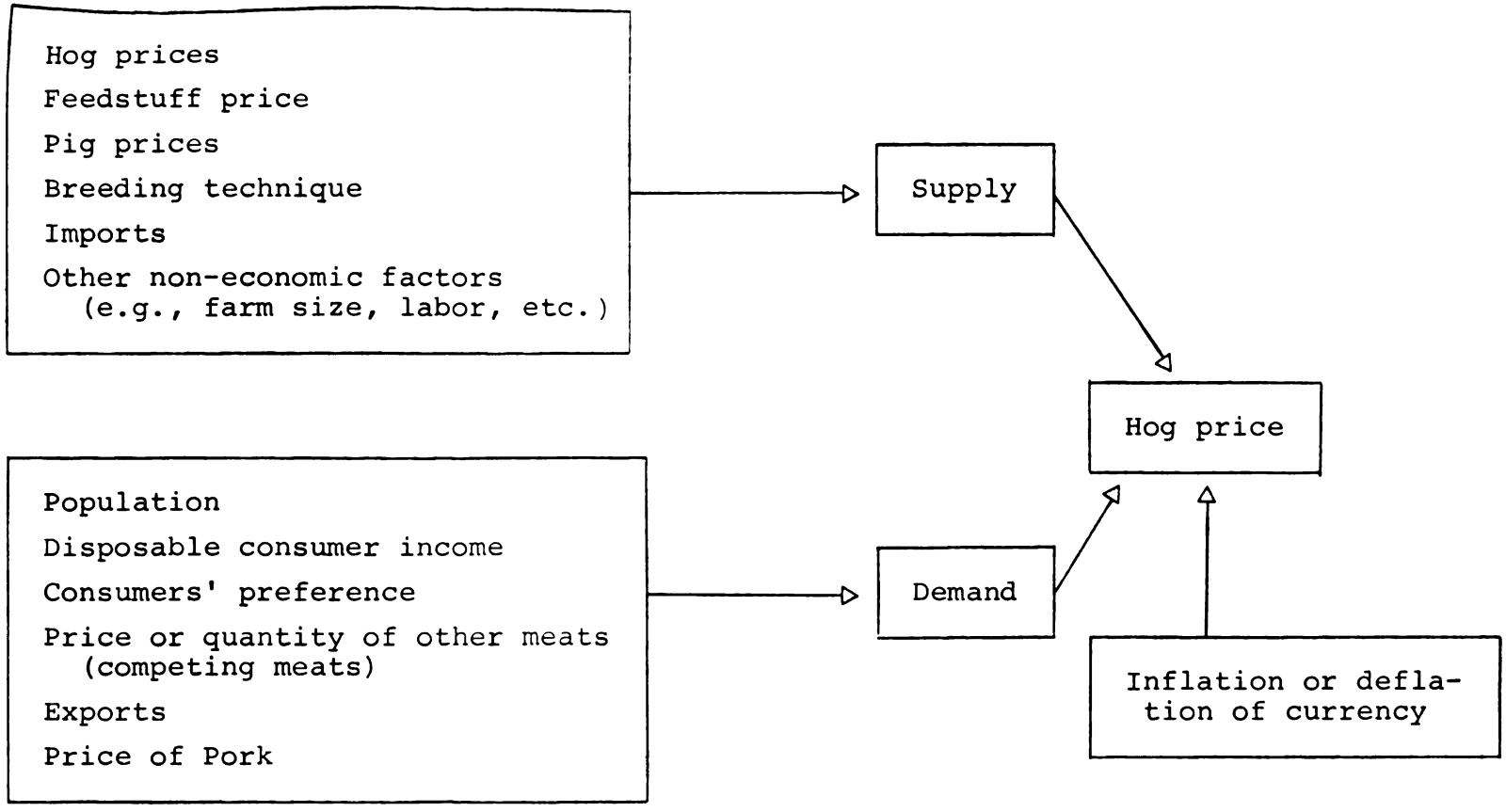
Before analyzing the trend in hog prices, further examination of some of the factors affecting hog prices should be helpful.

The long-time movement of hog prices in Taiwan, like any other price movement, is related to changes in supply and demand. Some of these were discussed previously in Chapters II and III. They are also breifly shown in Figure 4-1.

The information in Table 4-1 and Figure 4-2 shows that hog prices at the farm have moved upward in the period of 1951-1968 except for 1958, 1962, 1966, and 1967. Hog prices, in terms of current dollars, were NT$ 606.57 per 100 kilograms in 1951, increasing to NT$2,181.64 in 1968, an increase of 2.5 times in the last eighteen years, or an average annual increase of about 14 per cent. From 1961 to 1968 they increased about 50 per cent, or an average of 15 per cent a year.

Based on the linear trend, the equation of long-run hog prices at the farm is:

$$(Ph) = 526.18 + 97.13\ t \text{ (origin 1950)}$$



Note: Arrows show direction of influence.

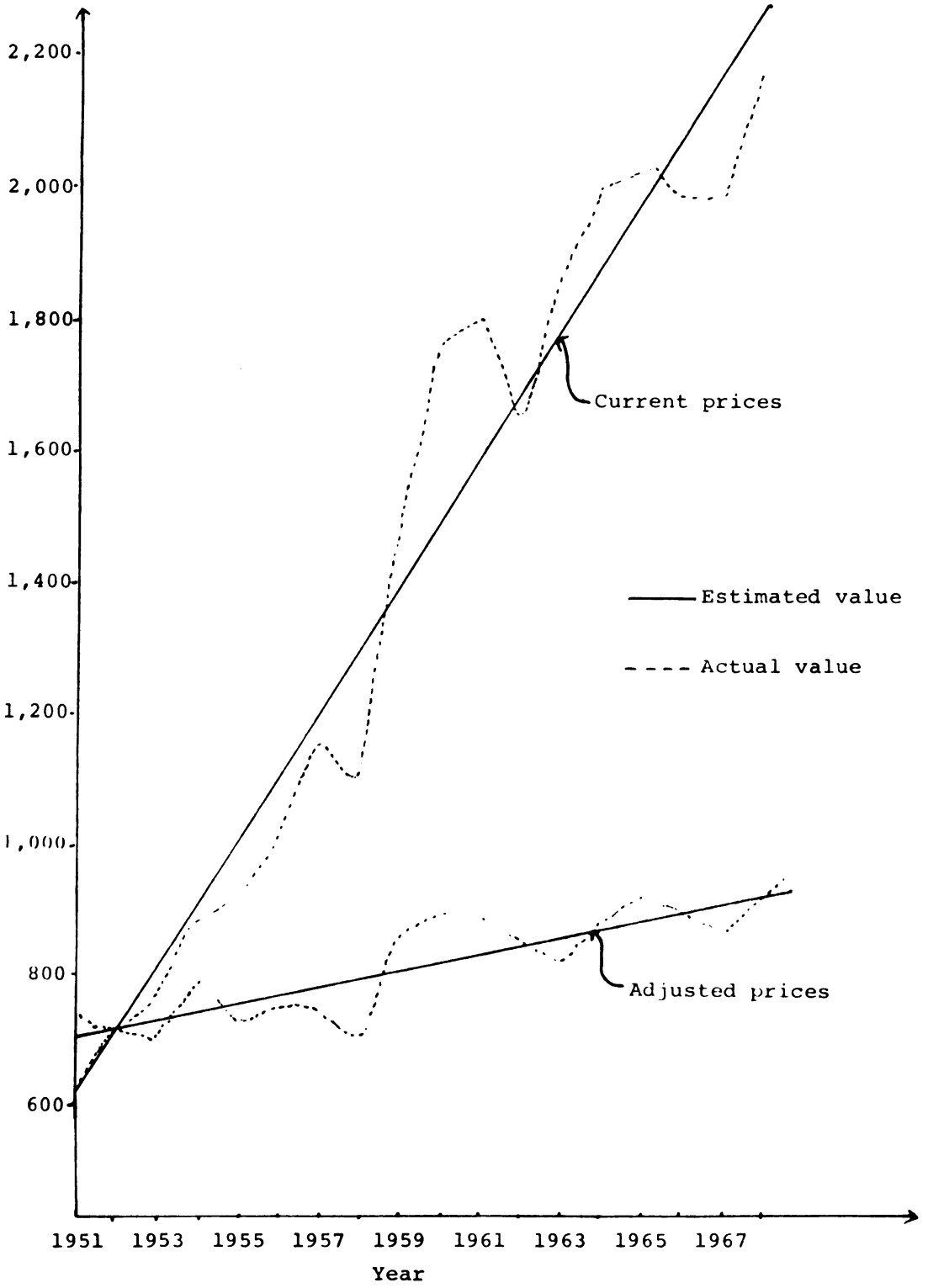
FIGURE 4-1.--The determination of hog prices in Taiwan.

TABLE 4-1.--Farm price of hogs in Taiwan, 1951-1968. (In New Taiwan dollars per hundred kilograms) (1951 = 100)

Year	Current Price		Adjusted Price*	
	Price (NT$) / 100kg.	Index	Price (NT$) / 100kg.	Index
1951	606.57	100.00	746.36	100.00
1952	720.07	118.67	720.07	96.42
1953	771.57	127.15	709.42	94.99
1954	891.03	146.84	800.28	107.18
1955	926.13	152.63	729.12	97.63
1956	1,088.35	179.36	760.23	101.79
1957	1,165.03	192.00	758.98	101.63
1958	1,108.01	182.60	712.55	95.41
1959	1,498.35	246.93	868.71	116.32
1960	1,778.22	293.05	903.25	120.94
1961	1,815.15	299.14	893.15	119.59
1962	1,656.78	273.04	790.90	105.90
1963	1,862.46	306.93	835.35	111.85
1964	2,018.62	332.67	883.58	118.31
1965	2,041.14	336.38	936.90	125.45
1966	1,992.98	328.44	901.42	120.70
1967	1,972.87	325.13	870.48	116.56
1968	2,181.64	359.53	943.82	126.38

*The current price adjusted with the index numbers of wholesale prices in Taipei.

Source: Taiwan Agricultural Price Survey Year Report (Taiwan: Taiwan Provincial Food Bureau, 1951-1968).



Source: Taiwan Agricultural Price Survey Year Report (Taiwan: Taiwan Provincial Food Bureau, 1951-1968).

FIGURE 4-2.--Hog prices at the farm in Taiwan, 1951-1968.

where

(Ph) = hog price at farm in terms of current NT$

t is time variable (year)

The regression coefficient in this equation is a positive value which indicates that hog prices at the farm have gone up NT$97.13 per hundred kilogram per annum, on the average for the eighteen years.

To eliminate the changes in the value of currency, the hog price at the farm was adjusted with the index of wholesale prices in Taipei. This price is called adjusted price or deflated price of hogs at the farm (see Table 4-1 and Figure 4-2). It shows the changes in hog prices at the farm in terms of real purchasing power.

The adjusted hog price at the farm in the period of 1951-1968 increased by 26 per cent or about one and one-half per cent a year. Prices in current dollars increased far more than 26 per cent, indicating that hog prices were highly associated with the inflation of currency. The linear equation of adjusted hog prices at the farm is as follows:

$$Ph = 700.02 + 12.67\ t \quad \text{(origin 1950)}$$

where

Ph is adjusted hog price at farm in NT$ per 100 kg.

t is time variable (year)

The secular trend of hog prices at the farm in terms of current value or adjusted price have shown an upward trend. The only difference between the current value and adjusted price was the former increased faster than the latter. In addition to the currency inflation, demand increased faster than supply. Economic theory indicates that when demand for a commodity moves to the right more rapidly than the supply, the price will rise.

Some of the factors associated with long-run changes in supply and demand have been explained in Chapters II and III. The rapid growth in the population and income per capita in this island have tended to increase the demand for hogs. The production of hogs in Taiwan for the past eighteen years, due to the technological programs in hog production, has also tended to increase. But the growth rate of supply lagged behind demand. Supply was limited by a shortage of cheap feedstuff and lower profits than from other farm enterprises.

When hog numbers available for slaughter each year are taken as the indicator of production and total pork consumption each year as an indicator of consumption, and a linear equation for production and consumption is computed, the following results are obtained:

$$N_s = 1,153,262.12 + 119,297.66\ t \quad \text{(origin 1950)}$$

$$Q_p = 62,875.66 + 10,240.28\ t \quad \text{(origin 1950)}$$

where

N_s = hog number available for slaughter each year

Q_p = total pork consumption in metric tons

t = time variable (year)

The growth rate of production is about 10 per cent and the growth rate of consumption is about 15 per cent.

It should be noted that while hog prices are the most important factor affecting the decision in regard to the quantity of hogs raised, hog producers are as much interested in the relative profit they can make as in the actual price they get from the product. From the foregoing analysis the fluctuations and upward movements of hog prices at farm during 1951-1968 period have been noted. Hog prices were increasing, but at the same time the prices of several other farm products were also showing an upward trend. This was especially true of some new crop operations such as mushrooms and some livestock products, such as eggs which, were more profitable than hog raising.[1] Therefore, many farmers planted mushrooms and engaged in the production of chicken eggs as a sideline business instead of hog raising. This is evidenced by the decreasing number of hog producers since 1957 (see Appendix Table A-1).

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[1]According to the Hsu' study (hog raising cost survey), the net profit per hog when labor is not counted was NT$134. If labor is counted as an expense, the net loss was NT$147 per hog.

Cycles in Hog Prices and Production

From Table 4-2 and Figure 4-3 it is noted that hog prices, in addition to having trended upward, have also exhibited cyclical fluctuations which are the rhythmic movement upward and downward, especially in the adjusted prices.

The results show that the current price has only one- and one-half cycles, while the adjusted hog price has three- and one-half cycles in eighteen years. The difference in the numbers of years in the cycle between the current and adjusted hog prices is related to the inflation of currency.

The adjusted data show that the length of the first cycle is four years (1951-1954). The second cycle length is six years (1955-1960), and the third cycle is five years (1961-1965). According to T. C. Wu, the June 1951 to July 1953 period was the first cycle which was about twenty-five months in length. The second cycle was twenty-six months in length (July 1953 to September 1955). The third cycle was forty months in length (September 1955 to January 1959). The fourth cycle was forty-six months (January 1959 to November 1962) in length. The fifth cycle was fifty-eight months in length (November 1962 to September 1967). Wu concluded that hog prices move in characteristic cycles averaging between three and four years.[2] The results

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[2]T. C. Wu, Agricultural Price Study in Taiwan (Taiwan: Provincial Department of Agriculture and Forestry, 1968), pp. 44-46. (Mimeographed)

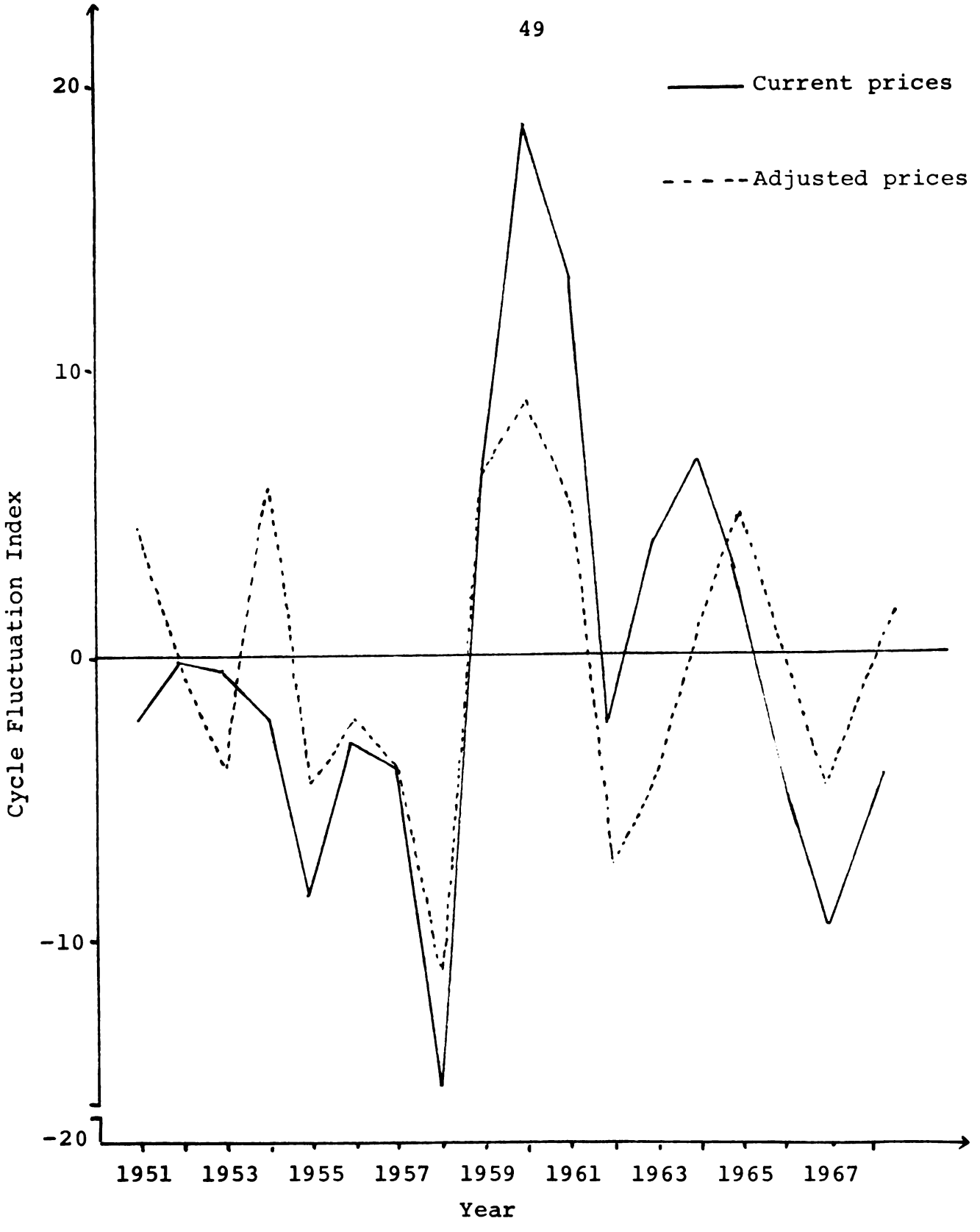
TABLE 4-2.--Cyclical fluctuation of hog prices at the farm, Taiwan, 1959-1968.

Year	Current Prices			Adjusted Prices		
	Observed Value (A) NT$/100kg.	Estimated* Value (B) NT$/100kg.	Cyclical Fluctuation Ratio[1]	Observed Value (A) NT$/100kg.	Estimated* Value (B) NT$/100kg.	Cyclical Fluctuation Ratio[1]
1951	606.57	623.41	- 2.70	746.36	712.68	4.73
1952	720.07	720.63	- 0.008	720.07	725.33	- 0.63
1953	771.57	817.85	- 0.57	709.42	739.99	- 4.13
1954	891.03	915.07	- 2.63	800.28	750.65	6.61
1955	926.13	1,012.29	- 8.51	729.12	763.30	- 4.48
1956	1,088.35	1,109.51	- 2.91	760.23	775.96	- 2.03
1957	1,165.03	1,206.73	- 3.56	758.98	788.61	- 3.76
1958	1,108.01	1,303.95	-15.03	712.55	801.27	-11.07
1959	1,498.35	1,401.17	6.93	868.71	813.93	6.73
1960	1,778.22	1,498.38	18.69	903.25	826.58	9.27
1961	1,815.15	1,595.69	13.76	893.15	839.24	6.42
1962	1,656.78	1,692.83	- 2.13	790.90	851.89	- 7.16
1963	1,862.46	1,790.05	4.04	835.35	864.55	- 4.37
1964	2,018.62	1,887.27	6.96	883.58	877.21	0.73
1965	2,041.14	1,984.48	2.86	936.90	889.86	5.29
1966	1,992.98	2,081.70	- 4.26	901.42	902.52	- 0.01
1967	1,972.87	2,178.92	- 9.46	870.49	915.18	- 4.88
1968	2,181.64	2,276.14	- 4.15	943.82	927.83	1.72

*Estimated value was obtained from the linear trend equation.

[1]Cyclical fluctuation ratio = $\frac{A}{B}$ x 100 - 100.

Source: Computed from Table 4-1.



Source: Computed from Table 4-1.

FIGURE 4-3.--Cyclical fluctuation of hog prices at the farm in Taiwan, 1951-1968.

obtained from using annual data were consistent with the results obtained in using monthly data.

These cycles in hog prices are related to opposite cycles in hog production. There is a considerable time lag in the response of production to change in price. The Cobweb Theorem is the theoretical tool that has been used as an explanation for cycles resulting from lags in production response to price.

According to the theorem, a small supply of hogs for market will raise the price of hogs. The rise in the price of hogs induces farmers to raise more hogs and this large supply of hogs will depress hog prices. The low price leads farmers to raise fewer hogs and so on. So a large supply and low price in one period will be followed by a small supply and an accompanying higher price in the next period, which, in turn, will be followed by a large supply and low price and so on.

This theorem also indicates that the fluctuation will either increase or decrease in amplitude, or continue at the same level indefinitely, depending upon the slopes of the demand and supply curves.[3]

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[3]When the elasticity of supply is greater than the elasticity of demand there is a divergent function. When the elasticity of supply is less than the elasticity of demand there is a convergent function. When the elasticity of supply is equal to the elasticity of demand there is a continuous function.

TABLE 4-3.--The cyclical fluctuations of hog production, Taiwan, 1951-1968.

Year	Number of Hogs for Slaughter			Total Slaughter Weight		
	Observed Value	Estimated Value	Cyclical Fluctuation Ratio	Observed Value	Estimated Value	Cyclical Fluctuation Ratio
1951	1,173,926	1,272,560	- 7.75	82,881	88,069	- 5.89
1952	1,258,167	1,391,857	- 9.61	93,966	100,407	- 6.42
1953	1,632,483	1,511,155	8.03	126,417	112,745	12.12
1954	1,713,148	1,630,452	5.07	130,612	125,082	4.42
1955	1,770,957	1,749,750	1.21	138,135	137,420	0.52
1956	1,930,782	1,869,048	3.30	148,670	149,758	- 0.73
1957	2,085,488	1,988,345	1.05	171,010	162,096	5.50
1958	2,373,708	2,107,643	12.62	198,798	174,433	13.97
1959	2,255,411	2,226,941	1.28	192,123	186,771	2.87
1960	2,139,633	2,346,239	- 8.81	181,084	199,108	- 9.05
1961	2,429,503	2,465,536	- 1.46	204,866	211,446	- 3.11
1962	2,607,017	2,584,834	0.86	217,401	223,784	- 2.85
1963	2,564,174	2,704,131	- 5.18	211,932	236,122	-10.25
1964	2,544,696	2,823,429	- 9.87	224,272	248,459	- 9.73
1965	2,694,925	2,942,727	- 9.42	271,412	260,797	- 7.44
1966	3,015,977	3,062,024	- 1.51	272,110	273,135	- 0.38
1967	3,439,764	3,181,322	8.12	314,627	285,472	10.21
1968	3,528,859	3,300,620	6.92	322,604	297,810	8.32

Source: Taiwan Agricultural Yearbook (Taiwan: Provincial Department of Agriculture and Forestry, 1951-1968).

The application of the theorem depends upon the fulfillment of three conditions: (1) producers plan for output in the next period on the basis of present prices, (2) once production plans are made, they are unalterable until the following time period, and (3) price is determined by the available supply.[4]

Production of hogs in Taiwan approximates these conditions. Price is of major importance in affecting future hog production. Hog production requires ten to twelve months for young pigs to reach slaughter weights. There is some variation in marketing weight in response to price and other factors, but supply is relatively fixed in any given year.

When the time-series data on the number of hogs for slaughter and the adjusted hog price at the farm as shown in Figure 4-4 were plotted, the negative relationship between hog prices and production was clearly evident. When measured with the cyclical fluctuation ratio as shown in Figure 4-5, the more regular rhythmic movement of expansion and contraction and the opposite movement in hog prices and the number of hogs for slaughter is noted.

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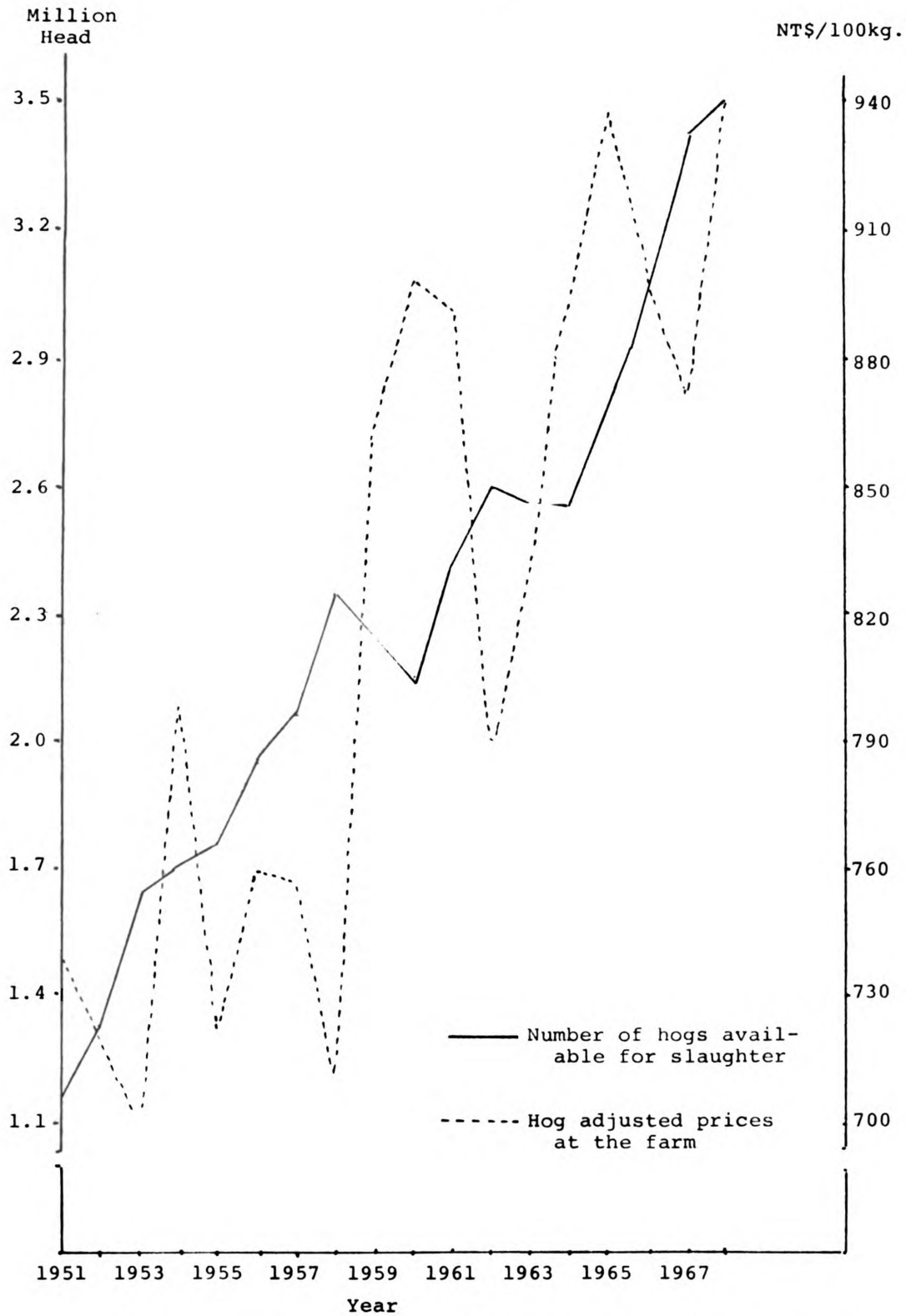
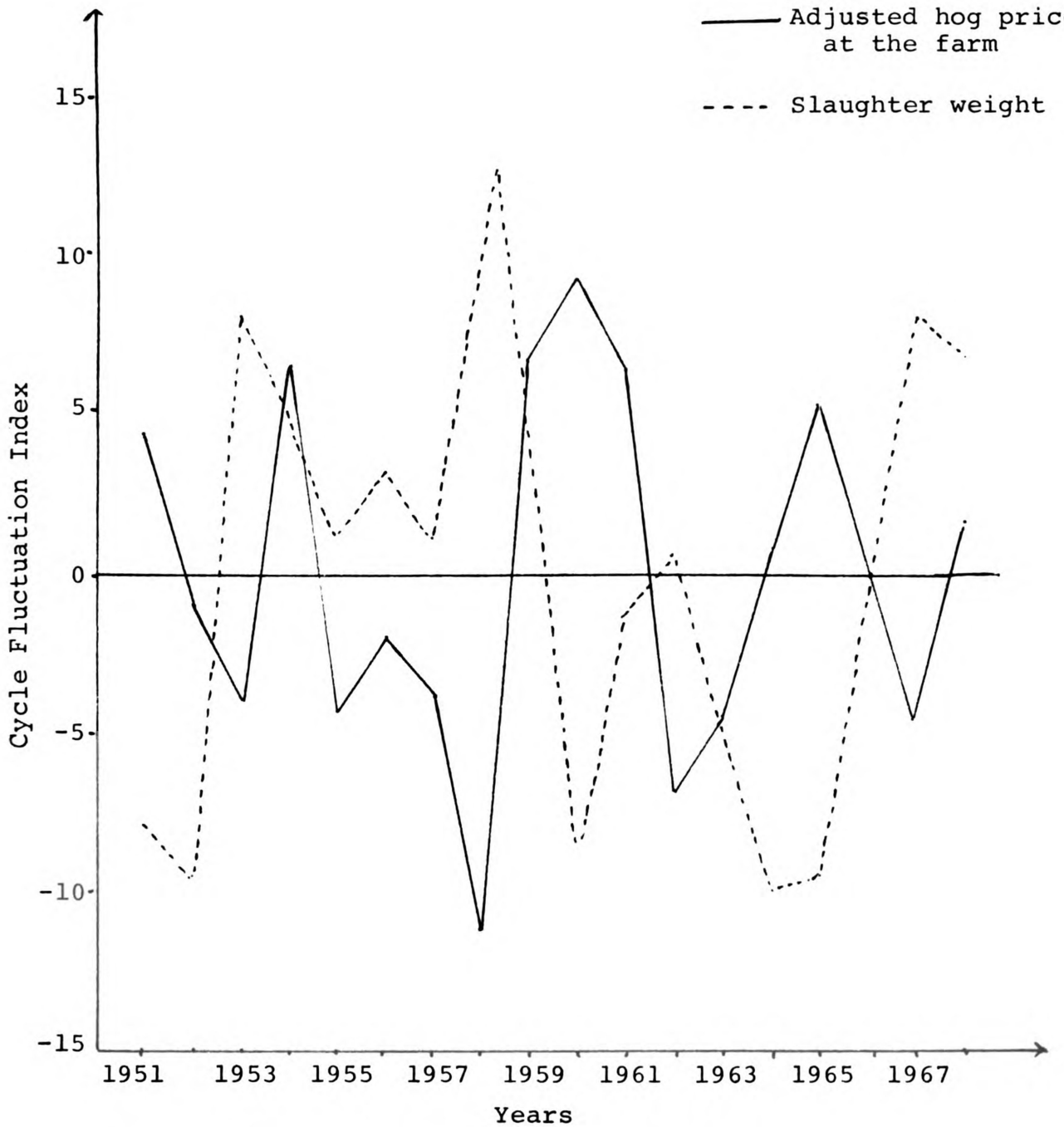
[4]Arthur A. Harlow, Factors Affecting the Price and Supply of Hogs, Technical Bulletin No. 1274 (Washingtin, D.C.: United States Department of Agriculture, 1962), p. 32.



Source: Number of hogs available for slaughter--see Table 2-1.
Adjusted hog price at the farm--see Table 4-1.

FIGURE 4-4.--Hog prices at the farm and hog production in Taiwan, 1951-1968.



Source: Slaughter weight--see Table 4-3.
Adjusted hog prices at the farm--see Table 4-2.

FIGURE 4-5.--Hog prices at the farm and hog production in Taiwan, 1951-1968. (Measured by cyclical fluctuation Index)

Seasonal Variation

The prices of most farm products exhibit a regular cyclic movement within the season--from a low price point during the weeks of heaviest market receipts to a high price peak later in the season when supplies are at their lowest.[5]

The seasonal index of hog price in the period of 1951-1968 with the monthly data computed using a centered twelve-month average method, is shown in Table 4-4 and plotted in Figure 4-6. Although hog raising is on a year-round basis in Taiwan, there is still a seasonal variation in hog prices. These variations stem from interrelated supply and demand factors which change seasonally.

In general, from April to August is the hot season in Taiwan. Less meat is consumed during this period and hog price trough seasonally in July. After August hog prices rise and attain a peak in December. It is affected by the weather which is cooler from October to January and also there are many religious and social festivals called Pai-Pai. The Pai-Pai is the great local feast and celebration. Much meat is consumed and pork plays the most important role. The peak prices are in December due to the New Year and lunar New Year which comes in January.

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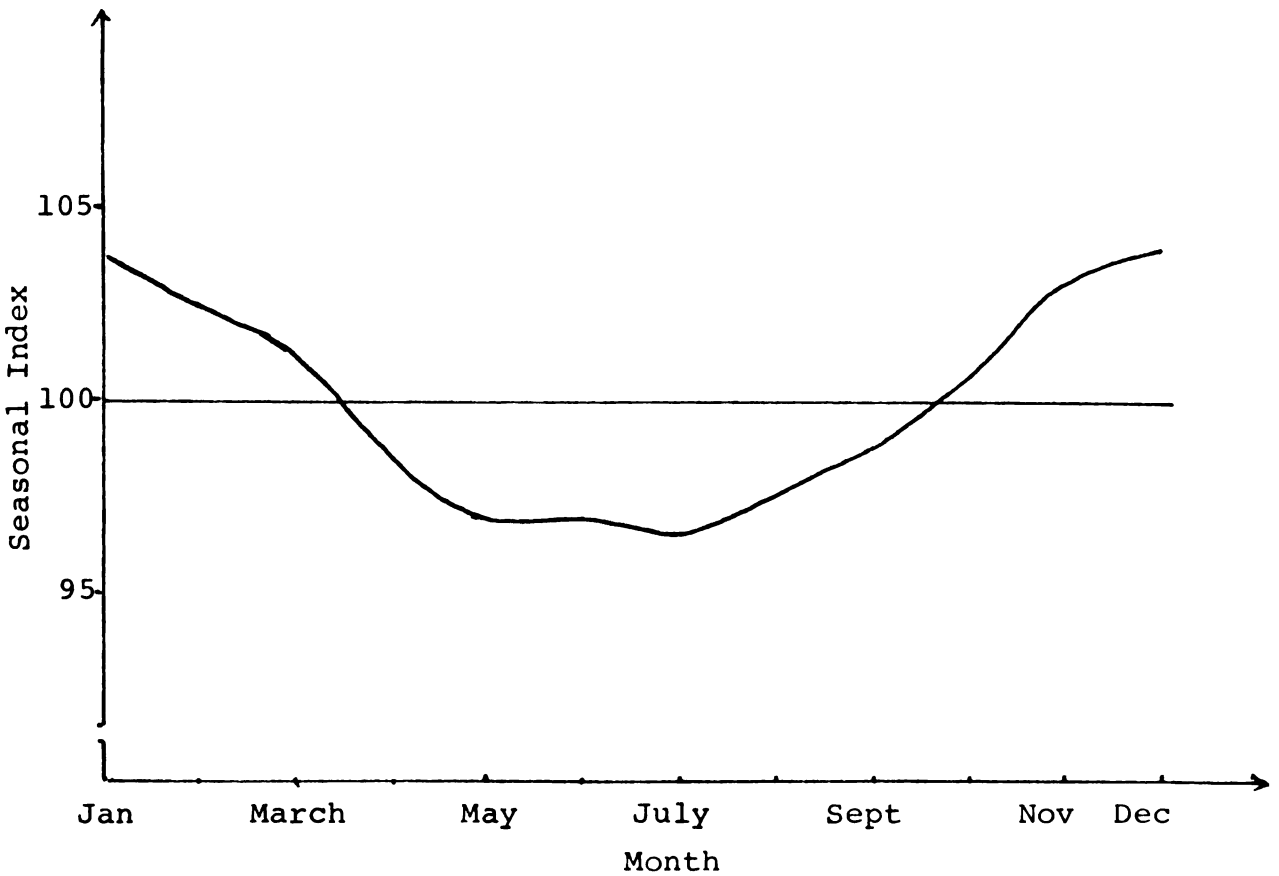
[5]Geoffrey S. Shepherd, Agricultural Price Analysis (5th ed.; Ames, Iowa: Iowa State University Press, 1964), p. 43.

TABLE 4-4.--Hog price by month, seasonal index, and average for the period, Taiwan, 1951-1967. (NT$/100kg.)

Year	Month											
	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
1951	530	532	544	545	530	549	573	644	661	691	735	743
1952	744	741	742	733	707	702	700	702	704	702	724	739
1953	756	755	734	707	699	693	697	751	800	854	895	918
1954	924	911	882	868	847	859	874	890	900	906	911	920
1955	928	921	914	896	889	898	897	897	898	920	1,012	1,042
1956	1,057	1,065	1,060	1,062	1,070	1,077	1,074	1,070	1,079	1,105	1,151	1,189
1957	1,199	1,195	1,201	1,194	1,156	1,132	1,127	1,137	1,140	1,155	1,167	1,176
1958	1,174	1,158	1,133	1,070	1,019	1,036	1,043	1,048	1,063	1,146	1,211	1,207
1959	1,200	1,217	1,313	1,348	1,360	1,514	1,590	1,719	1,702	1,639	1,666	1,711
1960	1,782	1,791	1,766	1,685	1,684	1,685	1,670	1,649	1,720	1,869	1,996	2,041
1961	2,028	1,967	1,884	1,734	1,745	1,786	1,757	1,745	1,758	1,786	1,804	1,784
1962	1,754	1,708	1,685	1,639	1,606	1,600	1,599	1,609	1,637	1,638	1,691	1,679
1963	1,714	1,711	1,743	1,806	1,826	1,840	1,878	1,899	1,917	1,946	2,025	2,043
1964	2,036	2,034	2,041	2,009	1,950	1,926	1,924	1,931	2,030	2,117	2,119	2,105
1965	2,109	2,092	2,046	1,988	2,012	2,014	2,003	2,007	2,037	2,054	2,045	2,085
1966	2,083	2,073	2,052	1,982	1,948	1,947	1,909	1,883	1,953	2,010	2,025	2,049
1967	2,022	1,973	1,957	1,942	1,925	1,915	1,928	1,930	1,991	2,011	2,020	2,053
Seasonal Index	103.7	102.4	101.1	98.5	96.8	96.9	96.5	97.7	98.8	100.7	103.3	103.9

Source: Taiwan Agricultural Price Survey (Taiwan: Taiwan Provincial Food Bureau, 1951-1967).



Source: See Table 4-4.

FIGURE 4-6.--Seasonal index of hog prices at the farm, Taiwan, 1951-1968.

On the other hand, March and April are the harvest months for sweet potatoes which are the main feedstuff for hog raising in Taiwan. After the end of the sweet potato production season, many hogs are moved to the market. Hog prices go down from April to July as a result of the increasing supply and decreasing consumption.

CHAPTER V

AN ECONOMIC AND STATISTICAL MODEL OF THE HOG ECONOMY OF TAIWAN

In this chapter an effort will be made to relate variables which theoretically appear to be associated with the hog economy in order to gain some understanding of the nature of the interrelationship involved. In any modern econometric investigation a few major steps are involved. These are: (1) specifying the system of relationships that are believed to have produced the observed data, (2) ascertaining whether these relationships can be identified for purpose of statistical analysis, (3) making the statistical analysis, and (4) interpreting the results.[1]

The first requires a knowledge of economic theory and of the particular relationships that hold for the commodity under consideration.[2] A diagram of the supply, demand, and price structure of the hog economy is presented first in order to help understand the nature of the interrelationship

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[1]Karl A. Fox, The Analysis of Demand for Farm Products, Technical Bulletin No. 1081 (Washington, D.C.: United States Department of Agriculture, 1953), p. 8.

[2]Ibid.

involved. Then, based on the relationships which are presented graphically on the supply, demand, and price structure, an effort will be made to ascertain whether a particular set of relationships can be identified, and, if so, formulate an economic and statistical model. Lastly, a statistical analysis of the factors that affect supply, demand, and price of hog based on the data is made.

According to Foote[3] the measurement of supply and demand is a complicated subject. Competent analysis requires three things. First, the analyst must have a thorough knowledge of the economic factors that affect the commodity and obtain adequate data on which to base the analysis. Second, he must understand economic theory in general. Third, he must be able to use modern techniques of analysis. The writer does not possess all the three requirements, but will try to do his best to learn something from this analysis.

Major Relationships in the Hog Economy

Diagrams that show the flow of commodities from producers to consumers in terms either of physical products or marketing demand and supply have been used for a long time. Albert M. Hermin used diagrams of the structure of price-making for wool to help in the price analysis of

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[3]Richard J. Foote, "Analytical Tools for Studying Demand and Price Structures," Agricultural Handbook No. 146 (Washington, D.C.: United States Department of Agriculture, 1958), p. 1.

apparel wool.[4] Sidney J. Armore has used diagrams of the economic factors affected by a change in the yield of cottonseed oil.[5] K. A. Fox has studied the demand and supply structures for perishable crops.[6] Such diagrams are useful in showing the relationships that affect the structure of demand, supply, and price of a commodity. These diagrams may be used: (1) to help the analyst think through basic factors and relationships involved, (2) to aid in the preparation of a logical analysis and writings of the economic structure of the industry, and (3) to assist the reader in following fairly complex relationships and discussion.[7]

A diagram of the hog economy in Taiwan for statistical measurement of the major economic relationships and variables is presented in Figure 5-1. Items that represent physical quantities are shown in boxes, while factors representing price and value appear in circles. The many forces

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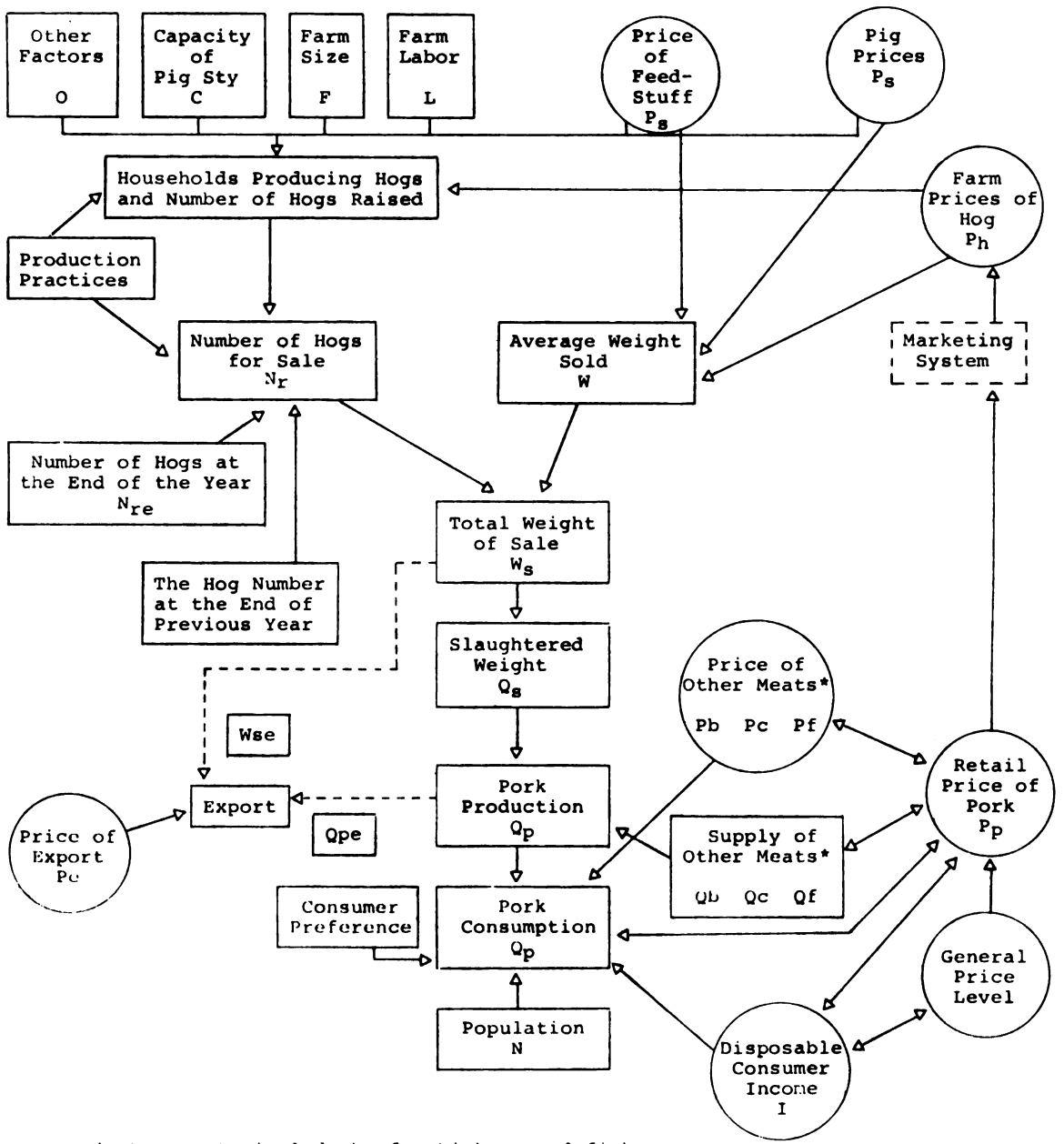
[4]Albert M. Hermin, Price of Apparel Wool, Technical Bulletin No. 1041 (Washington, D.C.: United States Department of Agriculture, 1959), p. 48.

[5]Sidney J. Armore, The Demand and Price Structure for Food Fats and Oils, Technical Bulletin No. 1069 (Washington, D.C.: United States Department of Agriculture, 1953), p. 69.

[6]Fox, The Analysis of Demand for Farm Products, p. 99.

[7]Foote, Analytical Tools for Studying Demand and Price Structures, p. 1.



*Other meats include beef, chicken, and fish.

Note: Arrows show direction of influence.

FIGURE 5-1.--The supply, demand, and price structure for hog in Taiwan.

that enter into or effect the marketing system are included within a single dash (-). The solid lines connecting the various items indicate the more important factors. Broken lines indicate factors that are relatively minor or operate only occasionally. Arrows indicate the principal directions of influence for each factor. Double pointed arrows indicate factors that are believed to be simultaneously related.

The symbols in some of the boxes and circles refer to the variables listed and to the equation on the economic and statistical models. But not all the factors that appear in the diagram are included in the equation (statistical model), because of data limitations and the requirement that the model be statistically manageable.

In the diagram a simultaneous relationship is indicated between the supply, demand, and price. In a market economy, prices are determined by the interaction of demand and supply so the factors which influence the supply and demand for hogs in Taiwan should be examined.

The supply in Taiwan is determined in part by the number of households raising hogs and the number of hogs raised by each household. It is assumed that farmers adjust their hog enterprise directly according to the following variables: (a) farm prices of marketable hogs, (b) feeder pig prices, (c) prices of feedstuffs, like sweet potato chop and soybean cake, etc., (d) the quantity of available by-products at the farm, (e) the supply of farm labor, (f) farm size, (g) capacity of the pig sty, (h)

estimated relative profitability of competing enterprises, and (i) other affecting factors. The first three of these factors are called price factors while the others are called non-price factors.

Usually, when the farmers have a large size farm, surplus farm labor, enough space in the pig sty, and sufficient available by-product at farm, a reduction in the price of feedstuff or feeder pigs, or a favorable hog price at the farm, these will be an incentive to increase the number of households raising hogs and the number of hogs raised per farm. This will be examined later. After deciding how many hogs to raise, the number of hogs to be sold, the average weight at sale time will be decided. Finally, through the process of slaughter, the total supply of pork at market will be determined.

The demand for pork is a function of many variables as discussed previously. The retail price of pork is a function of the total demand and total supply put on the market, assuming free competition.

The retail price of pork from which the marketing costs are deducted will influence the number of hogs for sale and the average weight for sale in short-run. For the long-run, this price will influence the number of households raising hogs and the number of hogs raised.

The current farm price of hogs will affect the number of producers and the number of hogs raised in the next period, and results in what is called a "causal chain" cycle.

The Economic Model of the Hog Economy

The set of structures that are compatible with the investigator's advance assumptions about the statistical universe from which the data are drawn is called a model.[8] The term economic model is applied to the set of structures consistent with the assumptions developed by the investigator from economic theory and knowledge of existing factors that relate to a particular commodity area. Thus an economic model is a set of equations that is consistent with the relationship and identities implied by the diagram.[9]

According to the simple description of the relationships from the diagram of the supply, demand, and price structure for hogs, a model of supply and demand for hogs is provided as supply and demand functions. In order to express the nature of the interrelationship involved in each function conveniently, symbolic forms of the variables involved are used. In general, the mnemonic device of denoting each variable by its first letter is followed although there are some exceptions to prevent duplication. For a lagged variable t-1 indicates a yearly lag for instance, $P_h(t-1)$ refers to the hog prices at the farm in the previous year. Variables in the model are defined as follows:

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[8] Foote, Analytical Tools for Studying Demand and Price Structures, p. 7.

[9] Ibid.

Nr = number of hogs produced (head)

Nre = number of hogs at the end of each year (head)

Ns = number of hogs available for slaughter (head)

W = average weight for sale per hog (kg)

Ne = number of hogs for export (head)

Ws = total weight of hogs for sale (metric ton)

Wse = total weight of hog for export (metric ton)

Qs = total slaughter weight (metric ton)

Qp = total quantity of pork produced (metric ton)

Qpe = total quantity of pork for export (metric ton)

Pp = deflated retail price of pork (NT$/Kg)

Ph = deflated hog price at the farm (NT$/100Kg)

Ps = deflated price of sweet potato chops (NT$/100Kg)

Pg = deflated price of feeder pigs (NT$/100Kg)

Pc = deflated price of chicken (NT$/Kg)

Pb = deflated price of beef (NT$/Kg)

Pf = deflated price of fish (NT$/Kg)

Qc = total quantity of chicken for market (metric ton) (supply for consumption)

Qb = total quantity of beef for market (metric ton)

Qf = total quantity of fish for market (metric ton)

Qbp = quantity of available by-product at farm

L = supply of labor at the farm

C = capacity of pig sty

F = farm size (hectare)

N = population (person)

Phe = price of hogs for export (NT$/100Kg)

Ppe = price of pork for export (NT$/kg)

I = per capita income (NT$)

M = marketing cost (NT$)

O = other factors

In the language that has been developed to consider statistical analysis of economic relationships, the variable whose values are explained by the structure are called endogenous variables, whereas those whose values are determined outside the structure are called exogenous.[10]

In general, complete models are required if we wish to derive estimates to be used for analytical purposes and for prediction, If we are interested only in ascertaining the probably magnitude of certain coefficients then, at times, a complete model is not required.[11] Foote also pointed out that balancing of the total number of endogenous variable with the total number of relationships frequently helps in the basic formulation of the model. After the complete model has been written down in symbolic forms, a decision may be reached at a later stage to fit statistically only part of the equations.[12]

Based on the complete model principle that one equation is needed for each endogenous variable, and according to the factors believed to be influential in the hog economy in Taiwan, there are twelve equations for an

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[10] Ibid., p. 8. [11] Ibid., p. 9. [12] Ibid., p. 10.

economic model which take the endogenous variables as dependent variables. They are written:

$$N = f\ (P_h\ (t-1), P_g, P_s, F, L, C, Q_{bp}, O) \qquad (5\text{-}1)$$

$$N_{re} = f\ (P_h, P_g, P_s, F, L, C, Q_{bp}, O) \qquad (5\text{-}2)$$

$$N_s = N + N_{re}\ (t-1) - N_{re} \qquad (5\text{-}3)$$

$$W = f\ (P_h, P_s, F, L, C, Q_{bp}, O) \qquad (5\text{-}4)$$

$$W_s = W \times N_s \qquad (5\text{-}5)$$

$$Q_s = W_s - W_{se} \qquad (5\text{-}6)$$

$$W_{se} = f\ (P_h, P_{he}, M, O) \qquad (5\text{-}7)$$

$$Q_{pe} = f\ (P_h, P_{pe}, M, O) \qquad (5\text{-}8)$$

$$Q_p = Q_s - Q_{pe} \qquad (5\text{-}9)$$

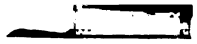
$$P_p = f\ \left(\frac{Q_p}{N}, \frac{Q_b}{N}, \frac{Q_c}{N}, \frac{Q_f}{N}, I\right) \qquad (5\text{-}10)$$

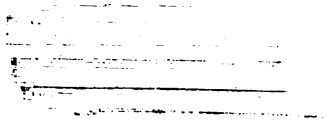
$$\frac{Q_p}{N} = f\ (P_p, P_b, P_c, P_f, I) \qquad (5\text{-}11)$$

$$P_h = f\ (P_p, M) \qquad (5\text{-}12)$$

The Simplified Economic Model

Among the twelve equations the endogenous variables are taken as dependent variables. There are four constant equations (5-3, 5-5, 5-6, 5-9) which could be eliminated by putting these variables in other equations. Of the eight





remaining equations, two are related to the export of hogs and pork. It has been mentioned before that the amount of exports was negligible. Another equation is associated with the price of pork and the price of hogs. The difference is the marketing cost and can be treated as one. Therefore, the twelve equations have been reduced to five.

Among these five equations, three are supply functions in terms of three dependent variables including the number of hogs produced, the total sale weight of hogs, and the number of hogs at the end of the year. The other two equations are demand functions, in terms of hog prices at the farm and per capita consumption, as dependent variables. The simplified economic model of hog economy of Taiwan is:

Supply functions

$$N_s = f\ (P_h\ (t-1),\ P_g,\ P_s,\ F,\ L,\ C,\ Q_{bp},\ O) \qquad (5\text{-}13)$$

$$Q_s = f\ (P_h\ (t-1),\ P_g,\ P_s,\ F,\ L,\ C,\ Q_{bp},\ O) \qquad (5\text{-}14)$$

$$N_{re} = f\ (P_h\ (t-1),\ P_g,\ P_s,\ F,\ L,\ C,\ Q_{bp},\ O) \qquad (5\text{-}15)$$

Demand functions

$$P_p = f\ \left(\frac{Q_p}{N},\ \frac{Q_b}{N},\ \frac{Q_c}{N},\ \frac{Q_f}{N},\ I\right) \qquad (5\text{-}16)$$

$$\frac{Q_p}{N} = f\ (P_p,\ P_b,\ P_c,\ P_f,\ I) \qquad (5\text{-}17)$$

Included in the supply function are the independent variables of farm size, quantity available by-products at the farm, supply of labor, capacity of pig sties, and other factors. These are considered very stable in the short run. These exogenous variables are assumed as being constant. The supply functions are rewritten as:

$$N_s = f\ (P_h\ (t-1),\ P_g,\ P_s\ /\ F,\ L,\ C,\ Q_{bp},\ O) \qquad (5\text{-}18)$$

$$Q_s = f\ (P_h\ (t-1),\ P_g,\ P_s\ /\ F,\ L,\ C,\ Q_{bp},\ O) \qquad (5\text{-}19)$$

$$N_{re} = f\ (P_h\ (t-1),\ P_g,\ P_s\ /\ F,\ L,\ C,\ Q_{bp},\ O) \qquad (5\text{-}20)$$

A Statistical Model of the Hog Economy

After formulating the economic model, the difficult task of locating or developing the necessary data and deciding upon the exact nature of the variables and relations to be used must be faced.[13] The structural relations must be provided and it is necessary to make additional assumptions. For example, the algebraic form of the relations and the specific way in which the relations are affected by unobserved influence must be specified. In formulating a statistical model the nature of the economic system to be analyzed should determine the type of equation to be used and the method used in fitting them.[14]

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[13]Karl A. Fox, Econometric Analysis for Public Policy (Ames, Iowa: Iowa State University Press, 1960), p. 35.

[14]Harlow, Factors Affecting the Price and Supply of Hogs, p. 66.

A statistical analysis of the supply and demand for hogs, based on the economic system equations which have been discussed earlier, is presented. A random disturbance term for each equation is added because the structural relations may include an unexplained residual. The assumptions made in this connection are:

1. The means of the disturbance terms in each equation are zero.
2. The variances are constant and independent of the independent variables.
3. The various values of the disturbance terms are independent.

The general equations of statistical form for the supply and demand functions of the simplified economic models are:

Supply functions:

$$N_s = f\ (P_h\ (t\text{-}1),\ P_g,\ P_s) + U_1 \qquad (5\text{-}21)$$

$$Q_s = f\ (P_h\ (t\text{-}1),\ P_g,\ P_s) + U_2 \qquad (5\text{-}22)$$

$$N_{re} = f\ (P_h\ (t\text{-}1),\ P_g,\ P_s) + U_3 \qquad (5\text{-}23)$$

Demand functions:

$$P_p = f\ \left(\frac{Q_p}{N},\ \frac{Q_b}{N},\ \frac{Q_c}{N},\ \frac{Q_f}{N},\ I\right) + U_4 \qquad (5\text{-}24)$$

$$\frac{Q_p}{N} = f\ (P_p,\ P_b,\ P_c,\ P_f,\ I) + U_5 \qquad (5\text{-}25)$$

where U_1, U_2, U_3, U_4, and U_5 are residual or error terms. There are many different forms of equations which may be used to represent different relationships of involved factors in the equation. In this study, the Cobb-Douglas function model is applied. The general form is:

$$y = Bo\ Xi^{Bi} + U \qquad N = 1.2... \ n$$

where

y is the dependent variable

B_o is intercept

Xi is the independent variable

Bi is the regression coefficient for each independent variable.

U is residual or error terms

The Cobb-Douglas function has the advantage that the regression coefficients of price, quantity, and income are immediately price and income elasticities of supply or demand respectively. In the meantime, the elasticities derived from this type of equation are constant in value no matter how the quantity of supply and demand may change. In this study, the equations of supply and demand are expressed in logarithmic terms.

For the statistical analysis an attempt is made to identify the effects of time for the supply and demand for hogs in Taiwan. Each equation will be analyzed by two models, one using time as a variable and another which does not.

Based on the general linear statistical model, the regression equations of the supply and demand for hogs in logarithmic form by two different models are:

Model I

Supply functions:

$$\log N_s = B_o + B_1 \log P_h\,(t-1) + B_2 \log P_g + B_3 \log P_s + U_1 \qquad (5\text{-}26)$$

$$\log Q_s = B_o + B_1 \log P_h\,(t-1) + B_2 \log P_g + B_3 \log P_s + U_2 \qquad (5\text{-}27)$$

$$\log N_{re} = B_o + B_1 \log P_h\,(t-1) + B_2 \log P_g + B_3 \log P_s + U_3 \qquad (5\text{-}28)$$

Demand functions:

$$\log P_p = B_o + B_1 \log \frac{Q_p}{N} + B_2 \log \frac{Q_b}{N} + B_3 \log \frac{Q_c}{N} + B_4 \log \frac{Q_f}{N} + B_5 \log I + U_4 \qquad (5\text{-}29)$$

$$\log \frac{Q_p}{N} = B_o + B_1 \log P_p + B_2 \log P_b + B_3 \log P_c + B_4 \log P_f + B_5 \log I + U_5 \qquad (5\text{-}30)$$

Model II

Supply functions:

$$\log N_s = B_o + B_1 \log P_h (t-1) + B_2 \log P_g + B_3 \log P_s + B_4 \log t + U_6 \quad (5\text{-}31)$$

$$\log Q_s = B_o + B_1 \log P_h (t-1) + B_2 \log P_g + B_3 \log P_s + B_4 \log t + U_7 \quad (5\text{-}32)$$

$$\log N_{re} = B_o + B_1 \log P_h (t-1) + B_2 \log P_g + B_3 \log P_s + B_4 \log t + U_8 \quad (5\text{-}33)$$

Demand functions:

$$\log P_p = B_o + B_1 \log \frac{Q_p}{N} + B_2 \log \frac{Q_b}{N} + B_3 \log \frac{Q_c}{N} + B_4 \log \frac{Q_f}{N} + B_5 \log I + B_6 \log t + U_9 \quad (5\text{-}34)$$

$$\log \frac{Q_p}{N} = B_o + B_1 \log P_p + B_2 \log P_b + B_3 \log P_c + B_4 \log P_f + B_5 \log I + B_6 \log t + U_{10} \quad (5\text{-}35)$$

where

U's are the random disturbance term for each equation. The simplest set of assumptions would be to state that: (1) the means of the disturbance terms in each equation are zero, (2) the variances are constant and independent of the independent variable, and (3) the various values of the disturbance terms are independent.

Regression Analysis for the Supply and Demand of Hog

Based on the conditions depicted in the theoretical, economic, and statistical models, ten regression equations for the supply and demand functions of hog with the two models were derived and fitted to data (Tables 5-1 and 5-2) of 1951-1968 period with the least square method used to estimate regression coefficients. The empirical results,[15] are as follow:

Model I

Supply function:

1. Using the number of hogs available for slaughter as the dependent variable, the following supply equation was obtained.

$$\log N_s = \underset{}{1.29} + \underset{(0.59)}{2.14^{a}} \log P_h\,(t-1) - \underset{(0.24)}{0.18^{e}} \log P_g - \underset{(0.34)}{0.30^{e}} \log P_s \text{ ---} \qquad (5\text{-}36)$$

$R^2 = 0.58$

$S = 0.089$

About 58 per cent of the change of hog supplies in terms of the number of hogs available for slaughter is

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[15] Here and in subsequent equations, (a) = significant at 1 per cent level; (b) = significant at 5 per cent level; (c) = significant at 10 per cent level; (d) = significant at 20 per cent level; and (e) = significant at 40 per cent level.

TABLE 5-1.--Data used in fitting supply function of hogs, Taiwan, 1951-1968.

Year	Time	Number of Hogs at the End of Year (Head)	Number of Hogs for Slaughter (Head)	Total Slaughtered Weight of Hogs (Metric Ton)	Price of Hogs NT$/100kg	Price of Pigs NT$/100kg	Price of Sweet Potato Chip NT$/100kg
1951	1	2,261,866	1,173,926	82,881	746.36	*	61.18
1952	2	2,610,929	1,258,167	93,966	720.07	*	99.13
1953	3	2,819,764	1,632,483	126,417	709.42	860.61	101.28
1954	4	2,871,169	1,713,148	130,612	800.28	1,272.68	71.11
1955	5	2,799,369	1,770,957	138,135	729.12	1,230.51	97.25
1956	6	3,040,663	1,930,782	148,670	760.23	1,143.48	105.34
1957	7	3,511,349	2,085,488	171,010	758.98	1,024.10	105.65
1958	8	3,572,882	2,373,708	198,798	712.55	935.49	87.86
1959	9	3,263,633	2,255,411	192,123	868.71	1,578.15	77.95
1960	10	3,164,571	2,139,633	181,084	903.25	1,576.17	128.17
1961	11	3,105,476	2,429,503	204,866	893.15	1,284.75	115.58
1962	12	2,921,218	2,607,017	217,401	790.90	1,029.46	113.82
1963	13	2,676,051	2,564,174	211,932	835.35	1,010.54	128.97
1964	14	2,717,822	2,544,696	224,272	883.58	1,473.74	92.97
1965	15	2,935,503	2,694,925	241,412	936.90	1,621.68	116.10
1966	16	3,110,066	3,015,977	272,110	901.42	1,295.00	102.75
1967	17	3,002,670	3,439,764	314,627	870.49	1,090.28	106.05
1968	18	3,010,564	3,528,859	322,604	943.82	1,091.93	106.40

*Data are not available.

Source: Number of hog at the end of year; number of hogs for slaughter and total slaughtered weight of hogs are from the Taiwan Agricultural Yearbook, 1951-1968 (Taiwan: Department of Agriculture and Forestry).

Data for the price of hogs, price of pigs, and price of sweet potato chop are from the Taiwan Agricultural Price Survey Yearly Reports (Taiwan: Provincial Food Bureau). All the prices were deflated prices using the wholesale price index of Taipei City, taking 1952 as the base period.

The data for the wholesale price index of Taipei City are from the Taiwan Statistical Data Book (Execute Yuan, Republic of China: Council for International Economic Cooperation and Development, 1966-1968).

TABLE 5-2.--Data used in fitting demand function of hogs, Taiwan, 1951-1968.

Year	Time	Per Capita Consumption of Pork (kg)	Beef (kg)	Chicken (kg)	Fish (kg)	Deflated* Price of Pork NT$/kg	Deflated* Price of Beef NT$/kg	Deflated* Price of Chicken NT$/kg	Deflated* Price of Fish NT$/kg	Per** Capita Real Income NT$
1951	1	8.78	0.74	2.05	13.34	15.8	11.2	19.3	8.3	3,728
1952	2	9.57	0.37	2.06	14.97	16.0	11.9	19.6	8.6	4,017
1953	3	12.38	0.36	2.19	17.10	16.1	13.9	21.6	8.8	4,146
1954	4	12.39	0.30	2.20	18.70	17.6	14.9	23.6	8.5	4,194
1955	5	12.48	0.32	2.15	19.99	16.4	13.6	21.1	7.9	4,409
1956	6	12.91	0.31	2.15	20.09	17.1	12.4	22.4	7.7	4,450
1957	7	14.46	0.30	2.07	20.87	16.9	13.9	23.5	7.9	4,620
1958	8	15.92	0.27	2.19	22.08	16.4	15.6	23.6	7.8	4,702
1959	9	14.70	0.27	2.18	22.52	19.3	17.9	23.9	7.7	4,091
1960	10	13.92	0.30	2.13	22.85	19.5	18.5	22.9	9.0	5,033
1961	11	15.25	0.33	2.13	26.58	18.4	21.0	24.7	8.6	5,281
1962	12	15.67	0.54	2.11	27.00	17.5	18.6	24.3	7.3	5,419
1963	13	14.80	0.72	2.28	27.83	17.8	17.4	21.7	6.8	5,913
1964	14	15.19	0.70	2.29	29.01	18.1	18.3	23.2	6.6	6,716
1965	15	15.87	0.40	2.34	28.45	20.0	25.3	23.6	8.8	6,903
1966	16	17.38	0.42	2.51	32.73	21.3	28.2	24.1	9.2	7,241
1967	17	19.64	0.52	2.77	33.45	20.1	24.2	23.1	8.6	7,712
1968	18	19.61	0.65	3.03	34.91	22.3	22.1	22.4	8.2	8,271

*Deflated price was adjusted with the wholesale price index in Taipei City.

**Per capita real income was based on the data of Taiwan Statistical Data Book and were adjusted for gain or loss due to changed terms of trade at 1964 constant price.

Source: Total population: Taiwan Statistical Data Book (Execute Yuan, Republic of China: Council for International Economic Cooperation and Development, 1966-1968).

Per capita consumption of pork based on the total slaughter weight of hog which was from the Taiwan Agricultural Yearbook (Taiwan: Taiwan Provincial Department of Agriculture and Forestry, 1951-1968), multiplying slaughtered weight by 83 per cent and divided by total population.

Per capita consumption of chicken was obtained from the number of chickens at the end of the year, multiplying by two and multiplying by 1.5 kg, and dividing total population. The number of chickens at the end of the year was taken from the Taiwan Agricultural Yearbooks (Taiwan: Taiwan Provincial Department of Agriculture and Forestry, 1951-1968).

Total slaughtered weight of beef data was taken from Taiwan Agriculture Yearbook (Taiwan: Taiwan Provincial Department of Agriculture and Forestry, 1951-1968).

Total production of fish data are from Taiwan Fisheries Year Book (Taiwan: Taiwan Fisheries Bureau, 1951-1968).

All the price data of pork, beef, chickens, and fish are taken from Taiwan Price Statistical Monthly Bulletin (Taiwan: Taiwan Provincial Bureau of Accounting and Statistics, 1951-1968).

explained by the effects of hog price in the previous year, pig prices, and the price of sweet potato chops. The other 42 per cent is explained by the changes of other relevant factors. It was mentioned in a prior chapter that the swine industry in Taiwan is rather a sideline business of farmers rather than being large-scale hog farms. Perhpas this explains why farmers adjusted their hog enterprise only partially according to the price of hogs, pigs prices, and the price of feedstuff. In addition to these price factors, there were some other non-price factors, e.g., the quantity of available by-products at the farm, farm size, the supply of farm labor, and capacity of pig sties, etc., which played an important role in influencing hog production in Taiwan. Farmers raise hogs in order to utilize their surplus labor and some farm by-products are transformed into pork for increased farm income. Also, farmers raise hogs in order to increase the fertility of soil by use of manure. Hsu's[16] survey provided evidence of this. Thirty-five per cent of those in his survey raised hogs in order to increase the fertility of soil by manure, 26 per cent in order to increase farm income, 24.2 per cent in order to use the available by-products of the farm, 11.6 per cent to utilize the surplus farm labor, and 3.2 per cent from other motivations. He also pointed out that the number of hogs raised

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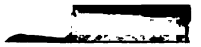
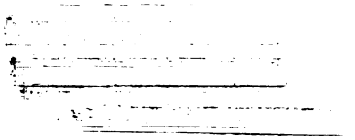
[16]Hsu, The Cost Survey of the Hog Raised in Taiwan, p. 258.





had a high relationship to farm size and the supply of labor. The correlation coefficients were 0.91 and 0.66, respectively.

All coefficients have correct signs. The coefficient for the independent variable of hog prices during the previous year is significantly different from zero at the 0.5 per cent level, and the other two are significant at the 40 per cent level.

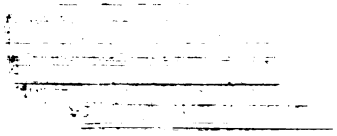
The effects of changes in the independent variables upon the number of hogs available for slaughter are:

a. A change of 1 per cent in hog prices in the previous year is associated with a change in the supply of hogs in terms of the number of hog for slaughter of 2.14 per cent in the same direction.
b. An increase of 10 per cent in feeder pig prices, ceteris paribus, is associated with a decrease in the hog supply of 1.8 per cent.
c. A change of 10 per cent in the price of sweet potato chops is associated with, ceteris paribus, a 3 per cent decrease in hog supply.

2. Using the <u>total slaughter</u> weight as the dependent variable, the supply equation is:

$$\log Q_s = 1.27 + \underset{(0.73)}{2.68^a} \log P_h\,(t-1) - \underset{(0.29)}{0.15} \log P_g - \underset{(0.42)}{0.38^e} \log P_s \qquad (5\text{-}37)$$

$R^2 = 0.59$ $\qquad$ $S = 0.089$



About 59 per cent of the variance in the total slaughter weight was explained by the variance in hog prices in the previous year, feeder pig prices, and the price of sweet potato chops. The remaining 41 per cent was associated with the variance of other factors.

In addition to the number of hogs raised, the marketing weight of the hogs also influenced the hog supply on the market, because the total slaughter weight equals the number of hogs available for slaughter, times the average slaughter weight. The average sale weight of hogs is also affected by price and non-price factors. The price factors are hog prices and the price of feedstuffs. Non-price factors are urgently required credit, the farmer's idea of the most profitable weight, and the difference in hog prices for different weights.

Chang[17] found that the usual marketing weight of hogs was determined 41 per cent of the time by the farmers' idea of the best weight at which to sell, 21 per cent were influenced by the farmers' urgent need for money, and 14 per cent by the price difference between weights and grades and only 10 per cent was related to the actual level of hog prices.

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[17]Wen-Pao Chang, "A Study of Hog Production in Taiwan" (unpublished master thesis, National Taiwan University, 1964), p. 64.

All coefficients have the expected sign and the coefficient of the prices in the previous year was significantly different from zero at the 1 per cent level and the coefficient of the price of sweet potato chops was significant at the 40 per cent level.

An increase of 1 per cent in hog prices in the previous year was associated with a 2.68 per cent increase in the total slaughter weight. A change of 10 per cent in feeder pig prices, other things remaining unchanged, was associated with a 1.8 per cent change in the total slaughter weight in the opposite direction. Similarly, an increase of 10 per cent in the price of sweet potato chops was associated with a 3.8 per cent decrease in the total slaughter weight.

Compared with equations 5-36 and 5-37, the farmer's response to price suggested more sensitivity to market weights than to the number of hogs raised, especially in the case of hog prices and the prices of feedstuff.

3. Using the number of hogs at the end of the year as the dependent variable, the supply equation is:

$$\log N_{re} = \underset{}{6.70} + \underset{(0.32)}{0.14} \log P_h\ (t-1) - \underset{(0.13)}{0.031} \log P_g - \underset{(0.18)}{0.08} \log P_s \qquad (5\text{-}38)$$

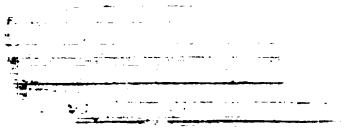
$$R^2 = 0.27$$

$$S = 0.039$$

Only about 27 per cent of the change in the number of hogs at the end of the year is explained by the change of hog prices in the previous year, pig prices, and the price of sweet potato chops, and the remaining 73 per cent is related to other factors.

Even though all coefficients have the expected sign, all of them are less than their standard errors and all coefficients are not significantly different from zero at the 40 per cent level. This suggests the supply equation in terms of the number of hogs at the end of the year is relatively unimportant. The number of hogs being raised at the particular time (at the end of each year) apparently does not represent the actual market supply of hogs, because before 1963 the hogs raised from young pigs required about fourteen to sixteen months to reach slaughter weight. After 1963 an integrated swine production program was launched. By improving hog breeding and providing concentrated feeds that shortened the time from young pigs to slaughter weights to about eight to ten months.

The effects of changes in the independent variable upon the number of hogs at the end of the year are less important than upon the number of hogs available for slaughter and the total slaughter weight. A change of 10 per cent in hog prices in the previous year was associated with a 1.4 per cent change in the number of hogs at the end of the year, in the same direction, while an increase of 10 per



cent in pig prices and the price of sweet potato chops was associated with 0.3 and 0.8 per cent decrease, respectively, in the number of hogs at the end of the year.

Demand function:

1. Using deflated pork prices as the dependent variable the demand equation is:

$$\log P_p = 0.13 - \underset{(0.25)}{0.40^d} \log \frac{Q_p}{N} - \underset{(0.05)}{0.13^a} \log \frac{Q_b}{N} + \underset{(0.27)}{0.42^d} \log \frac{Q_c}{N} + \underset{(0.29)}{0.31^e} \log \frac{Q_f}{N} + \underset{(0.26)}{0.26^e} \log I \qquad (5\text{-}39)$$

$R^2 = 0.85$

$S = 0.020$

About 85 per cent of the variance in the deflated pork prices at the retail level, was explained by the variation in per capita income and per capita consumption of pork, beef, chicken, and fish. The remaining 15 per cent is related to other factors. This study yields the same findings as did Hsia's.[18] Based on annual data for 1950-1959, he used per capita income and per capita consumption of pork and fish as independent variables, and found that the coefficient of determination was 0.90.

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[18]Hsia, A Demand Analysis of Hog in Taiwan, p. 144.

The signs of the coefficient for per capita consumption for chicken and fish are not as expected in this study. All coefficients are greater than their standard errors, except the coefficient of per capita income which is the same. The unexpected signs of the coefficient for per capita consumption for chicken and fish may be related to the time series data of imports and exports which are not available. Both play important roles for fish consumption in Taiwan in the different periods.

In this context, an increase of 1 per cent in per capita consumption of pork (or the production of pork) was associated with, on the average, a change in the opposite direction of 0.40 per cent in the pork prices at the retail level. This is the retail price flexibility coefficient and the demand elasticity of pork at retail level will be 2.5. Similarly, an increase of 10 per cent in the per capita consumption of beef was associated with a 1.3 per cent decrease in pork prices at the retail level. This reflects the degree of competition between pork and beef for the consumer's dollar.

Fish in Taiwan are a popular food and an important source of animal protein in the diet. Hsia pointed out that pork and fish compete with each other. The substitute ratio of fish for pork was 0.45.[19] But this study suggests

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[19] Ibid., p. 149.

they are supplementary products. An increase of 1 per cent in the per capita consumption of fish was associated with an increase of 0.31 per cent in pork price at the retail level. Similarly, an increase of 1 per cent in per capita consumption of chicken is associated with 0.42 per cent increase in pork price. With respect to the per capita consumption of fish and chicken, the signs of the coefficients were unexpected. Meanwhile, the coefficients are not significantly different from zero at the 10 per cent level. It would be expected that an increase in the supply or consumption of chicken and fish would reduce the pork price. However the results could be accepted on logical grounds; that chicken and fish are supplementary goods with pork in the diet.

An increase of 1 per cent in the per capita income was associated with a change in the same direction of 0.26 per cent in the pork price at the retail level. It is believed that pork consumption will further increase in the future because the level that people are consuming today appears to be still far below the saturation point. So an increase in per capita income would be associated with more pork consumption (demand) and thus ease the pressure as pork price goes up.

Since complete time-series data regarding the import and export of fish and beef were not available, the writer used the price of competeting or substituting meats as

independent variables. The following demand equation was obtained:

$$\log P_p = -0.81 + \underset{(0.019)}{0.003} \log P_b + \underset{(0.47)}{0.29} \log P_c + \underset{(0.19)}{0.32^d} \log P_f + \underset{(0.24)}{0.41^d} \log I - \underset{(0.23)}{0.36} \log \frac{Q_p}{N} \qquad (5\text{-}40)$$

$R^2 = 0.81$

$S = 0.022$

Even though all coefficients have the expected signs, the coefficient of determination is less than the equation which used per capita consumption as independent variables. The effects of changes in the independent variables upon pork prices at the retail level are:

a. If the price of beef, chicken, and fish increased 1 per cent, the pork price is expected to increase 0.003, 0.29, and 0.32 per cent, ceteris paribus.

b. An increase of 1 per cent in per capita income was associated with 0.41 per cent increase in the pork price.

c. An increase of 1 per cent in per capita consumption of pork (supply) was, on the average, associated with 0.36 per cent decrease in the pork price and the demand elasticity of pork was 2.77.

2. Using per capita consumption of pork as the dependent variable, the demand equation was estimated as:

$$\log \frac{Q_p}{N} = -3.04 - \underset{(0.71)}{1.21^d} \log P_p + \underset{(0.24)}{0.25^e} \log P_b +$$

$$\underset{(0.55)}{1.06^c} \log P_c + \underset{(0.27)}{0.28^e} \log P_f + \qquad (5\text{-}41)$$

$$\underset{(0.25)}{0.83^a} \log I$$

$$R^2 = 0.85 \qquad S = 0.029$$

About 85 per cent of the variation in per capita consumption of pork was explained by the variance in per capita income, and the prices of pork, beef, and chicken, and 15 per cent by the variance of other factors. This estimate is very close to Hsia's result ($R^2 = 0.90$).[20]

All coefficients have the expected signs and all are greater than their standard errors. The coefficient for per capita income is significant at the 1 per cent level, the coefficient for the price of chicken is significant at the 10 per cent level, the coefficient of pork price is significant at the 20 per cent level, and those for the price of beef and fish are significant at the 40 per cent level.

The coefficient of pork price is the demand elasticity of pork and the coefficient of price of beef, chicken, and

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[20] Ibid., p. 144.

fish are cross elasticities which are defined as the percentage change in per capita consumption for pork associated with a 1 per cent change in price of beef, chicken, and fish.

In this context a change of 1 per cent in pork prices is associated with 1.21 per cent change in the opposite direction of the per capita consumption of pork, the other condition remaining unchanged. An increase of 1 per cent in beef prices is associated with 0.25 per cent increase in per capita consumption of pork. Similarly, an increase of 10 per cent in the price of chicken and beef are associated with 10.6 and 2.8 per cent in per capita consumption of pork, respectively. The small effects of the price of beef upon the per capita consumption of pork implies that they are not highly competitive in Taiwan. The results are consistent with the results where per capita consumption is used as dependent variable.

A change of 1 per cent in per capita income is associated with 0.83 per cent change in per capita consumption of pork, in the same direction.

Model II

Time frequently is introduced into regression analysis as a measure of technological change. If no such variable can be found, but an explanation of the time trend in terms of technological or institutional developments is available, then a time variable should be introduced into the

analysis.[21] This provides an additional variable which may be associated with the unexplained residuals. When the time-series data have a time trend in terms of technological and institutional development, and time is not introduced as an independent variable, the error of specification would be increased.

For convenience in comparing the two models with respect to the affect of time upon the change of supply and demand of hogs, the supply and demand equations in the following two tables (Tables 5-3 and 5-4) are given. In comparing the supply equations of Models I and II, it was found that the time variable had a high relationship to the unexplained residuals. The determination coefficient of the equation of the dependent variable of the number of hogs at the end of the year is increased from 0.58 (5-36) to 0.96 (5-42). Similarly, the total slaughter weight, dependent variable equations (5-37 and 5-43) and the equation of the number of hogs at the end of the year (5-29 and 5-44) are increased from 0.59 to 0.96 and 0.27 to 0.50, respectively. These figures imply that about 38 per cent, 37 per cent, and 23 per cent of the change in hog supplies in terms of the number of hogs available for slaughter, total slaughter weight, and the number of hogs at the end of the year is explained by the time trend which involved

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[21] Foote, Analytical Tools for Studying Demand and Price Structure, p. 27.

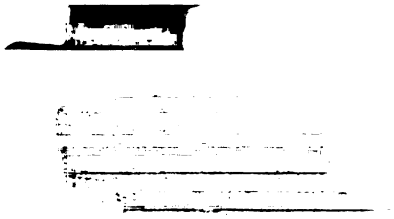

TABLE 5-3.--Supply equation of hogs in Taiwan, 1951-1968.

Model	Dependent Variable	Interception B_o	Hog Price in Previous Year $P_h(t-1)$	Pig Price P_g	Price of Sweet Potato Chop P_s	Time t	R^2	S	Elasticity of Supply	Equation Number
I	Number of hogs available for slaughter N_s	1.29	2.14[a] (0.59)	-0.18[c] (0.24)	-0.30[e]		0.58	0.089	2.14	5-36
	Total slaughtered weight Q_s	1.27	2.68[a] (0.73)	-0.15 (0.29)	-0.38[e]		0.59	0.089	2.68	5-37
	Number of hogs at the end of the year N_{re}	6.70	0.14 (0.32)	-0.03 (0.13)	-0.08 (0.18)		0.27	0.039	0.14	5-38
II	Number of hogs available for slaughter N_s	6.68	0.30[c] (0.23)	-0.33[b] (0.07)	-0.30[a] (0.11)	0.43[a] (0.04)	0.96	0.021	0.30	5-42
	Total slaughtered weight N_{re}	5.34	0.42[c] (0.32)	-0.33[a] (0.09)	-0.37[b] (0.13)	0.53[a] (0.05)	0.96	0.029	0.42	5-43
	Number of hogs at the end of the year N_{re}	7.17	0.15 (0.45)	-0.04 (0.13)	-0.08 (0.19)	0.04 (0.07)	0.50	0.041	0.15	5-44

TABLE 5-4.--The demand equations of hog in Taiwan, 1951-63.

Model	Dependent Variables	Intercept	Per Capita Consumption for: Pork $\frac{Qp}{N}$	Beef $\frac{Qb}{N}$	Chicken $\frac{Qc}{N}$	Fish $\frac{Qf}{N}$	Deflated Price of: Pork P_p	Beef P_b	Chicken P_c	Fish P_f	Per Capita Income I	Time	R^2	S	Demand Elasticity	Equation Number
	Pork prices P_p	0.13	-0.40[d] (0.25)	-0.13[a] (0.05)	0.42[d] (0.27)	0.31[e] (0.29)					0.26[e] (0.26)		0.85	0.020	2.50	5-39
I	Pork prices P_p	-0.81	-0.36 (0.23)					0.003 (0.019)	0.29 (0.47)	0.32[d] (0.19)	0.41[d] (0.24)		0.81	0.022	2.77	5-40
	Per capita consumption of pork	-3.04					-1.21[d] (0.71)	0.25[e] (0.24)	1.06[c] (0.55)	0.28[e] (0.27)	0.83[a] (0.25)		0.85	0.029	1.21	5-41
	Pork prices P_p	0.25	-0.41[d] (0.27)	-0.12[c] (0.06)	0.47[c] (0.32)	0.24 (0.42)					0.25[e] (0.28)	0.03 (0.02)	0.85	0.021	2.43	5-45
II	Pork prices P_p	-0.49	-0.38[e] (0.24)					0.09 (0.21)	0.22 (0.48)	0.48[c] (0.24)	0.35[d] (0.25)	0.09[e] (0.08)	0.83	0.022	2.63	5-46
	Per capita consumption of pork	-2.27					-1.34[d] (0.92)	0.36[d] (0.25)	0.85[d] (0.57)	0.53[d] (0.34)	0.69[b] (0.23)	0.14 (0.11)	0.87	0.029	1.34	5-47

technological or institutional changes. These estimates are consistent with what was found in Chapter 2.

In addition to having a larger coefficient of determination for the supply function, it was found that the supply elasticity of hogs becomes smaller, except in the case of the equation of the number of hogs at the end of the year. The elasticity of supply reduced from 2.14 to 0.30 in the equations 5-36 and 5-42, and from 2.68 to 0.42 in the equations 5-37 and 5-43. This implies that when the time variable is used the hog supply is indicated as become more inelastic.

The coefficient of independent time variable for the three supply equations in terms of the numbers of hogs available for slaughter (N_s), total slaughter weight (Q_s), and the number of hogs at the end of the year (N_{re}) have the expected sign. They are also larger than their standard error and are significantly different from zero at the 1 per cent level, except for equation 5-44. An increase of 1 per cent in time was associated with 0.43 and 0.53 per cent increase in the number of hogs available for slaughter and total slaughter weight, respectively. Similarly, a 10 per cent change in time was associated with 0.4 per cent change in the same direction in the number of hogs at the end of the year, other things held constant.

For the demand equations, the independent time variable was less important than in the supply equation. The

determination coefficients of these demand equations are increased from 0.81 to 0.83 in equations 5-40 and 5-46, from 0.85 to 0.87 in equations 5-41 and 5-47, and equations 5-39 and 5-45 are unchanged. This implies that about 2 per cent of the variation in pork prices and per capita consumption of pork can be explained by the variation of time. However, the other demand equation which used the per capita consumption of meats as an independent variable, and the price of pork as a dependent variable, showed no influence by the passage of time.

All coefficients of the time variable for the three demand equations are larger than their standard errors and have the expected signs, and are significantly different from zero at the 40 per cent level except for equation 5-45. However, the effects of the time variable upon the dependent variable are not as large as for the supply equations. An increase of 1 per cent in time is associated with 0.03 per cent increase in the pork price (use quantity as variables). Similarly, a 1 per cent change in time was associated with 0.09 and 0.14 per cent changes in pork prices (using price as an independent variable) and per capita consumption of pork, in the same direction, with other things remaining equal.

CHAPTER VI

SUMMARY, CONCLUSIONS, AND IMPLICATIONS

In this study an attempt has been made to analyze and interpret the economic background and development of the swine industry in Taiwan. Data for the 1951-1968 period were used. The findings of this study have certain implications for policy. A summary of the findings, along with the implications for policy, are discussed below:

1. Hogs are an important product for Taiwan farmers. The total production value of hogs is second to rice in Taiwan. Consumption of pork also occupies an important position. In total family living expenses, expenditure for pork ranks second to rice. This means that government policy for the swine industry is not only important for producers and the prosperity of the rural economy and national income, from the standpoint of nutrition and social welfare. It is therefore important that a careful analysis of the factors affecting production, consumption, and price be made.

2. An analysis of the demand and supply of hogs, using the number of hogs available for slaughter each year as an indication of production, and total pork consumption

each year as an indicator of consumption was made. The growth rate of production has lagged behind demand growth. The former is about 10 per cent per year and demand growth is 16 per cent annually. Therefore it seems appropriate that the government might encourage farmers to increase hog production in order to meet the growth in demand.

3. The high growth rate of the demand for pork was associated with growth in population, per capita income, changes in price of pork and competing meats, and other factors, such as consumer preference. Among these factors, population growth was most important, explaining about 60 per cent. Per capita consumption of pork increasing less rapidly than total consumption of pork during 1951-1968 period is good evidence. The growth rate of per capita consumption of pork was only 6.8 per cent annum.

In the meantime, the increase of per capita income also played a vital role in the increased demand. According to the findings of this study, the income elasticities are 0.83 and 0.69 for Model I and Model II, respectively. High population and national income growth are expected over the next ten years. If the anticipated growth rates of 2.25 and 4.5 per cent, respectively, materialize, increased demand for hogs can be expected.

4. The record of hog supplies in Taiwan is one of prolonged expansion. Coupled with an increase in the number of hogs available for slaughter, total slaughter weights

have steadily increased during the past eighteen years. The growth rate was 11 per cent per annum in the number of hogs available for slaughter, and 16 per cent per year in total slaughter weight due to heavier average weight per head.

The upward trends in total slaughter weight and the number of hogs available for slaughter resulted from several factors. These include: an increase in demand, technological progress, favorable hog prices for farmers, prices of inputs, etc. Among these factors, technological progress has played the most important role in the larger supply of hogs in Taiwan. Favorable hog prices for the farmer stands at the next position. The price of inputs is third.

5. During recent years, a majority of producers raised crossbred hogs to shorten the market time from young pigs. Disease and parasite control also have helped reduce the risk involved in pork production.

Farmers have responded well to the new technology, especially to the improvement in hog breeding, artificial insemination, and hog vaccination. There is still a need, however, for more effective control of hog diseases, especially pasteurellosis. Only a small part of the farmers have adopted the concentrated feed and cooperative marketing service, etc. (see Table A-1). So constant research in such problems and improvements in agricultural extension are needed.

6. Increased hog production in the future will require much larger quantities of feedstuff. Unfortunately, the area planted to sweet potatoes, which is the main hog feed, has decreased slightly year by year since 1955 due to the government policy of encouraging rice production. Due to the lagging supply of feedstuff, particularly for sweet potatoes, the prices of sweet potatoes have tended upward. This has retarded the progress of the swine industry in Taiwan. In order to tackle this problem, the government should either encourage the production of more feedstuff or import cheaper feedstuffs to meet domestic needs. Otherwise, the higher feedstuff prices could result in less production or slower rates of increase in hog production.

7. Economic literature points out that, when demand has unit elasticity, total revenue is not affected by changes in price. If demand is elastic, total revenue varies inversely with price. If demand is inelastic, total revenue varies directly with price. Since the demand elasticity of hogs is larger than one, the government might encourage an increase in production. Maintaining a reasonable price for producers, however, is very important because of a very low profit margin for hog raising in Taiwan (see Table A-2).

8. Since it is uncommon for a farmer to slaughter and consume a whole hog by his own family, hog raising is almost completely commercialized. Due to the increasing

supply of and demand for hogs, the marketable quantity is increasing rapidly. A proper and effective marketing system and organization is needed.

Based on the record of the cooperative marketing program of farmers' association, the costs of bringing hogs from the farmers in the southern part of the island to Taipei City, which is located in the northern part, amounted to NT$ 80.20 or about 3.3 per cent of the consumer price (see Table A-4). Farmers' associations are non-profit organizations, and their services are rendered at cost. Presumably, other hog shippers render the shipping services at a higher margin. At present, only 5.65 per cent[1] of the hogs are handled through cooperative hog marketing programs. Methods of expanding and strengthening the cooperative marketing program which would be helpful in the development of the swine industry in Taiwan should be sought.

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[1]Hsu, A Study of Agricultural Marketing in Taiwan, (Taiwan: National Taiwan University, 1968), p. 52.

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APPENDIX

TABLE A-1.--The total number of hogs produced, the number of producers using common production practices, and the number and percentage using an integrated swine production program, Taiwan, 1952-1968.

Year	Total	Number of Producers Using Common Hog Practices	Number of Producers Participating in Integrated Swine Production Program	
			Number of Households	Per Cent
1952	695,082	695,082	--	--
1953	736,074	736,874	--	--
1954	711,385	711,385	--	--
1955	695,020	695,020	--	--
1956	756,998	756,998	--	--
1957	816,421	816,421	--	--
1958	803,670	803,670	--	--
1959	748,804	748,804	--	--
1960	734,991	734,991	--	--
1961	722,885	722,885	--	--
1962	701,050	701,050	--	--
1963	665,915	661,795	3,119	0.48
1964	668,827	656,118	6,709	1.01
1965	670,402	661,693	8,709	1.30
1966	679,553	660,984	18,569	2.73
1967	663,820	640,251	23,569	3.55
1968	651,362	625,773	25,569	3.95

*Integrated Swine Production Program was launched in 1963.

Source: Taiwan Rural Economy (Taiwan: Provincial Food Bureau, 1952-1968).

TABLE A-2.--Costs and returns of hog raising by regions in Taiwan, 1966 and 1967. (NT$ per 100 kg)

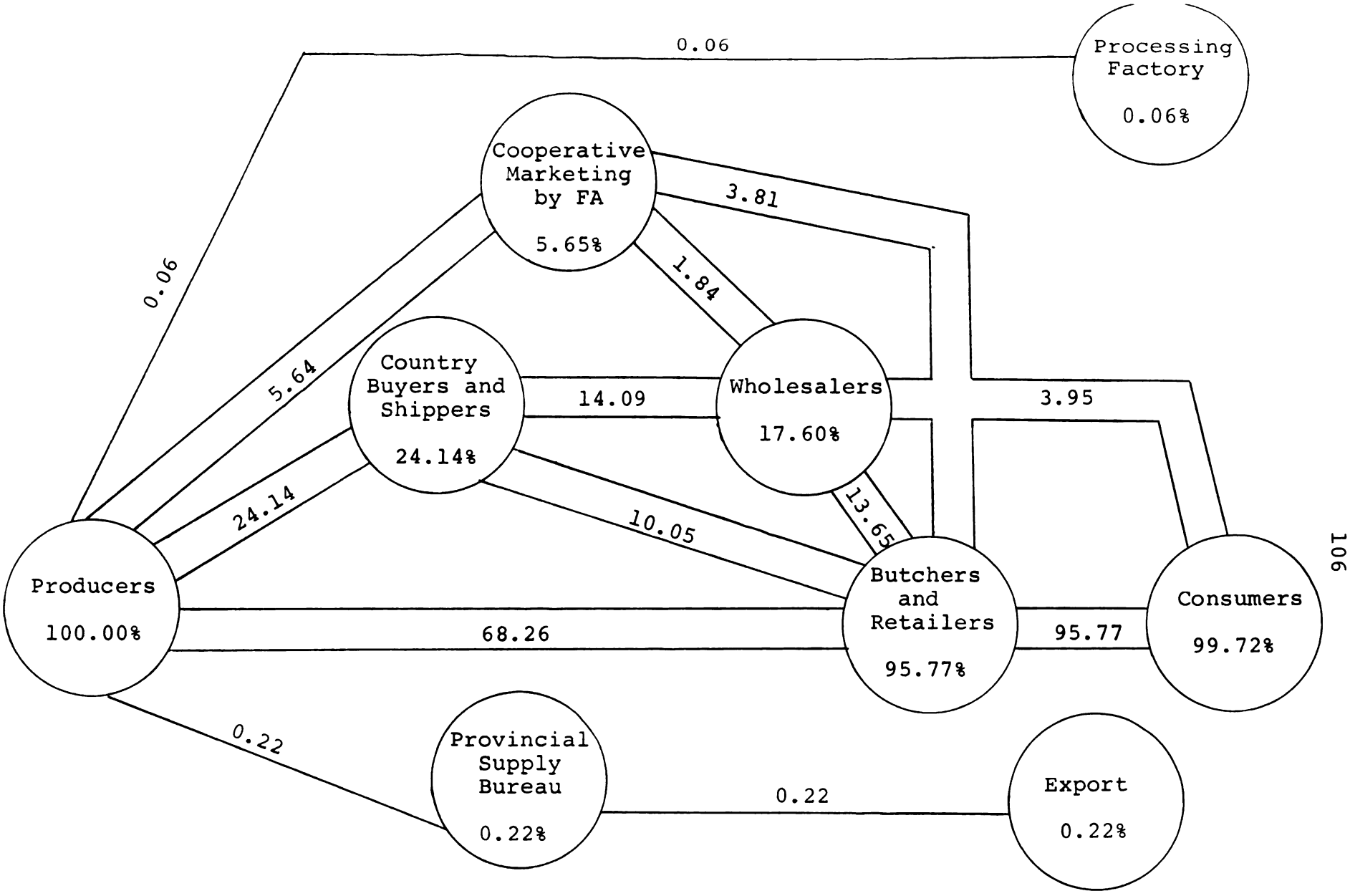
Regions	1966			1967		
	Costs	Returns	Net Profits	Costs	Returns	Net Profits
North	1,956	2,158	202	2,144	2,185	41
Central	1,897	2,022	125	1,976	2,006	30
South	1,906	1,922	16	1,939	2,023	84
East	1,761	1,922	161	1,929	1,985	56
Average	1,899	2,032	133	1,975	2,048	73

Source: Unpublished data obtained from the Joint Commission of Rural Reconstruction, Taiwan.

TABLE A-3.--Production costs for a hundred kilogram of hogs, Taiwan, 1963 and 1967. (NT$ per 100 kg)

Items	1963		1967	
	Amount	Percent of Total	Amount	Percent of Total
Feeder Pigs	275	10.47	328	16.01
Feedstuff	1,242	65.37	1,374	67.09
Fuel	115	6.05	62	3.03
Labor	204	10.74	126	6.15
Depreciation of Hog Spy	25	1.31	35	1.71
Depreciation of Facilities	14	0.74	17	0.83
Insurance for Disease	18	0.95	27	1.32
Interest	--	--	77	3.76
Other Expenses	7	0.37	2	0.10
TOTAL	1,900	100.00	2,048	100.00

Source: Unpublished data obtained from the JCRR, Taiwan.



Source: Wen-Fu Hsu, A Study of Agricultural Marketing in Taiwan (Taiwan: National Taiwan University, 1968), p. 52.

FIGURE A-1.--Marketing channel of hogs in Taiwan, 1965.

TABLE A-4.--Marketing margin for a hundred kilogram of hog in Taipei, Taiwan, 1969. (NT$ per 100 kg)

Items	Amount	Percent of Total
Farm price	1830.00	69.7
Transportation	80.20	3.3
Damage and loss weight for market	61.40	2.3
Livestock market fee	16.40	0.6
Profit for shipper and country buyers	35.40	1.3
Taxation of slaughter	280.00	10.6
Slaughter house rent	36.00	1.4
Material and fixed expense for retail	55.00	2.1
Profit for butcher and retailer	206.71	7.8
Other expenses	24.60	0.9
Consumer price	2625.71	100.00

Source: Unpublished data obtained from the Livestock Management Division (Taiwan: Taipei City Government).