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The Potato Market of La Paz, Bolivia
And the Effects of the Agrarian Reform

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All views, interpretations, recommendations and conclusions expressed in this paper are those of the author and not necessarily those of the supporting or cooperating organization.

The Potato Market of La Paz, Bolivia
And the Effects of the Agrarian Reform*

Stephen M. Smith**

INTRODUCTION

In Bolivia, the Quechua Indians have named several varieties of potatoes Runa or Imilla--man and young girl--thereby emphasizing the traditional significance of the potato in their cultural and economic lives. The potato remains today an extremely important crop to the economy and people of Bolivia.

Estimates of per capita consumption range from two to three hundred pounds per year. By weight, the potato is the largest crop in the country; by acreage planted, only corn, which is used primarily as a fermented beverage ingredient and for animal feed, is more important. The best land is used for potatoes; all available manure, commercial fertilizer, and irrigation water is given first to potatoes, often at the expense of a cash crop; and very much time and care is devoted to the potato crop. In fact, a significant portion of rural life is built around the potato and

*The author wishes to thank Professor A.C. Johnson, Department of Agricultural Economics, University of Wisconsin, for his suggestions and guidance. Professors Peter Dorner and Don Kanel also made helpful comments. However, the author assumes full responsibility for the opinions expressed in the paper.

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its season, so much so that migrants to the cities and to the tropical colonization areas of Bolivia only slowly lose their attachment to the raising and consuming of potatoes.

Because of the importance of the crop, it is imperative that rigorous studies of the potato market be initiated. The present study attempts to fulfill part of this need. Particular attention is paid to the differences in market relationships before and after Bolivia's Revolution and Agrarian Reform, begun in 1952-53. Such differences indicate that the Agrarian Reform has apparently altered the basic market structure of potatoes, a finding which should be of considerable interest to economic development planners.*

Methodology

The prices in the city of La Paz were chosen as representative of prices for the country as a whole. The main reason is that La Paz is by far Bolivia's largest city, and is located in one of the more densely populated regions of the country. In addition, it is the administrative capital and center of most of the nation's economic activity. The city is, therefore, the most important single market and also the one in which the pertinent price data are the most accurate. The remaining variables in this analysis relate to the nation as a whole.

Mention should be made of the data problems encountered in the study. Data on many of the variables deemed to be important (see flow chart, Figure 5), such as weather, acreage planted, and consumption data are not

*Studies by Ronald J. Clark [13] indicate that a general restructuring of the markets and marketing relations on the Bolivian Altiplano took place as a result of the Agrarian Reform. The present paper attempts to specify the particular changes occurring in the potato market.

available. In addition, production, population, and income data for the time period prior to 1950 were found only in scattered form. Besides dictating to some extent the final variables used in the analysis, this situation made it necessary to accumulate information piecemeal from the several data sources listed in the bibliography. Much of it was internally inconsistent, inconsistency from source to source, and expressed in many different forms with respect to units of measure, base periods, etc. An attempt was made to derive consistent series, using such techniques as deflation, index numbers to derive missing prices, and estimated growth rates to derive population figures. The prices for the years 1946-50, population figures for the 1940's, and the index numbers used to deflate the 1963-66 prices are the major results of such adjustments. The appendix contains a more detailed description of these procedures.

Data problems also determined the time span used in analyzing the factors affecting the price of potatoes. The pre-Revolution series includes the years 1944 and 1946-52. Earlier years and 1945 are not included because of the lack of production data for those years. The post-Revolution series includes the years 1955-65; 1953 and 1954 are excluded because no price or production data were found for those years. This lack of data undoubtedly reflects the fact that those were years of considerable upheaval and reorganization within the government. The years 1955-57 have been included in the analysis, although they may tend to effect the results adversely because price controls were in effect until December, 1956, causing abnormal price and production conditions. However, separate regressions with and without these years did not result in extreme differences.

Finally, the available data for 1966 were not included in the analysis. In all of the preliminary graphic analyses the data for this year were sufficiently different from the remaining years to cause an alteration in what appeared to be the basic structural relationships. Whether 1966 is a signal that a basic change was taking place in the potato market cannot be ascertained until additional data become available.

The study was further hindered by the fact that no relevant literature was found to provide a guideline for hypotheses, choice of variables, and checks of results.* Hopefully, the results of this paper may serve the purpose of guidelines for future studies.

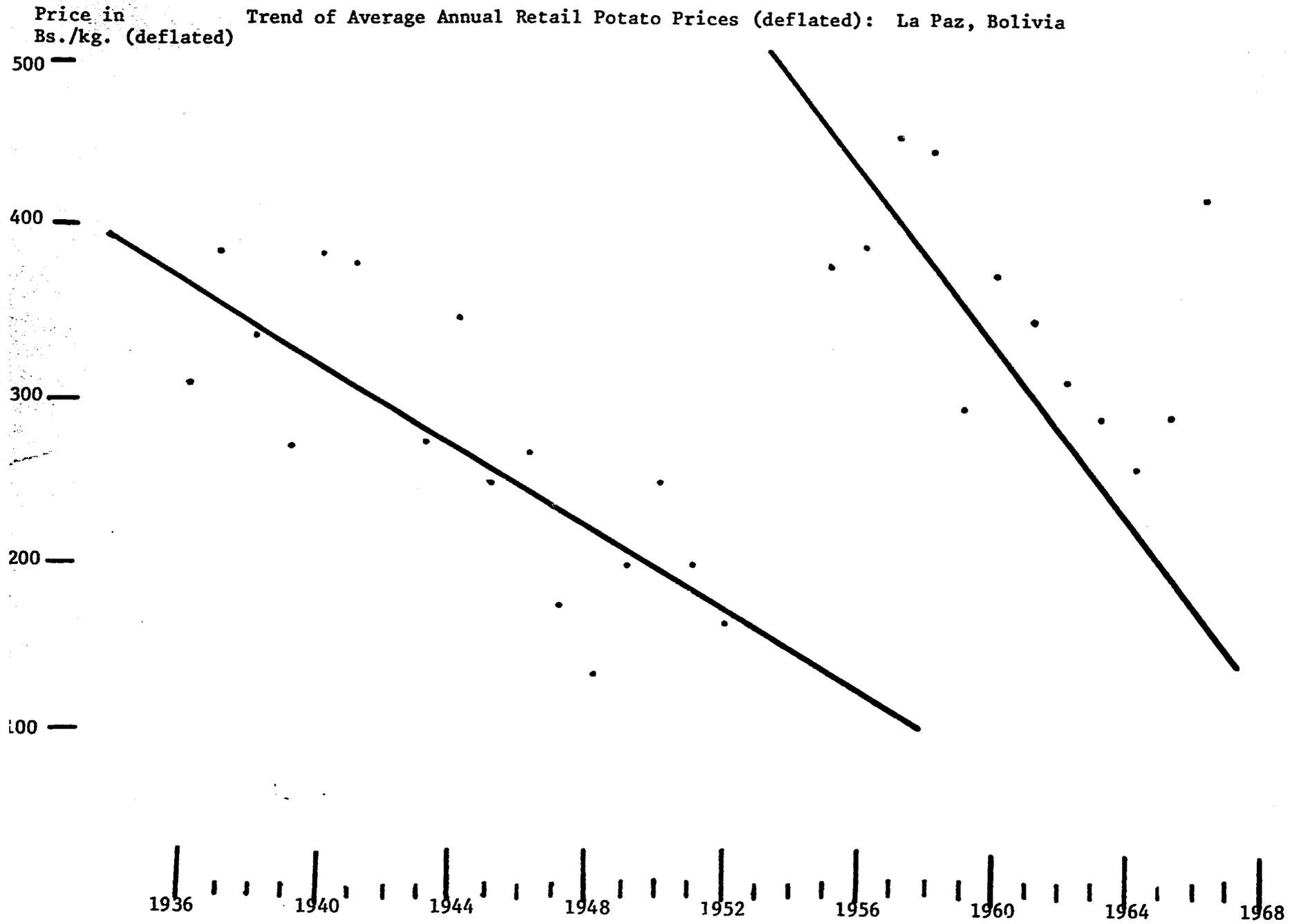
Long Run Trend

The average annual retail potato prices (deflated for general changes in the price level) for La Paz are plotted in Figure 1 for the years 1936-66. During this period there appears to be no overall trend in the price of potatoes. However, a closer examination reveals two distinct sub-periods during which pronounced downward trends are apparent. In the first period, 1936-52, the price of potatoes declined by .0125 bolivianos per kilo per year, and in the second period, 1955-65, by .027 bolivianos per kilo per year.

The downward trend of both periods can probably be attributed to increasing per capita production, increasing incomes and the increasing availability of substitutes, particularly in the later period. The fact that 1965 and 1966 seem to deviate from the trend cannot be accounted for

*The bibliography contains two studies [14,20] on Bolivia's inflation of the mid-1950's, which provide some insights on how to interpret data from that period.

Figure 1



at this time since price data later than 1966 were not found.

The division between the two subperiods comes precisely at the years when the Revolution occurred and the Agrarian Reform began, giving the first indication that those events affected the basic price relationships. In addition, the trend slope has more than doubled from the pre- to the post-Agrarian Reform period, implying increased rates of change in the above mentioned factors contributing to the downward trend.

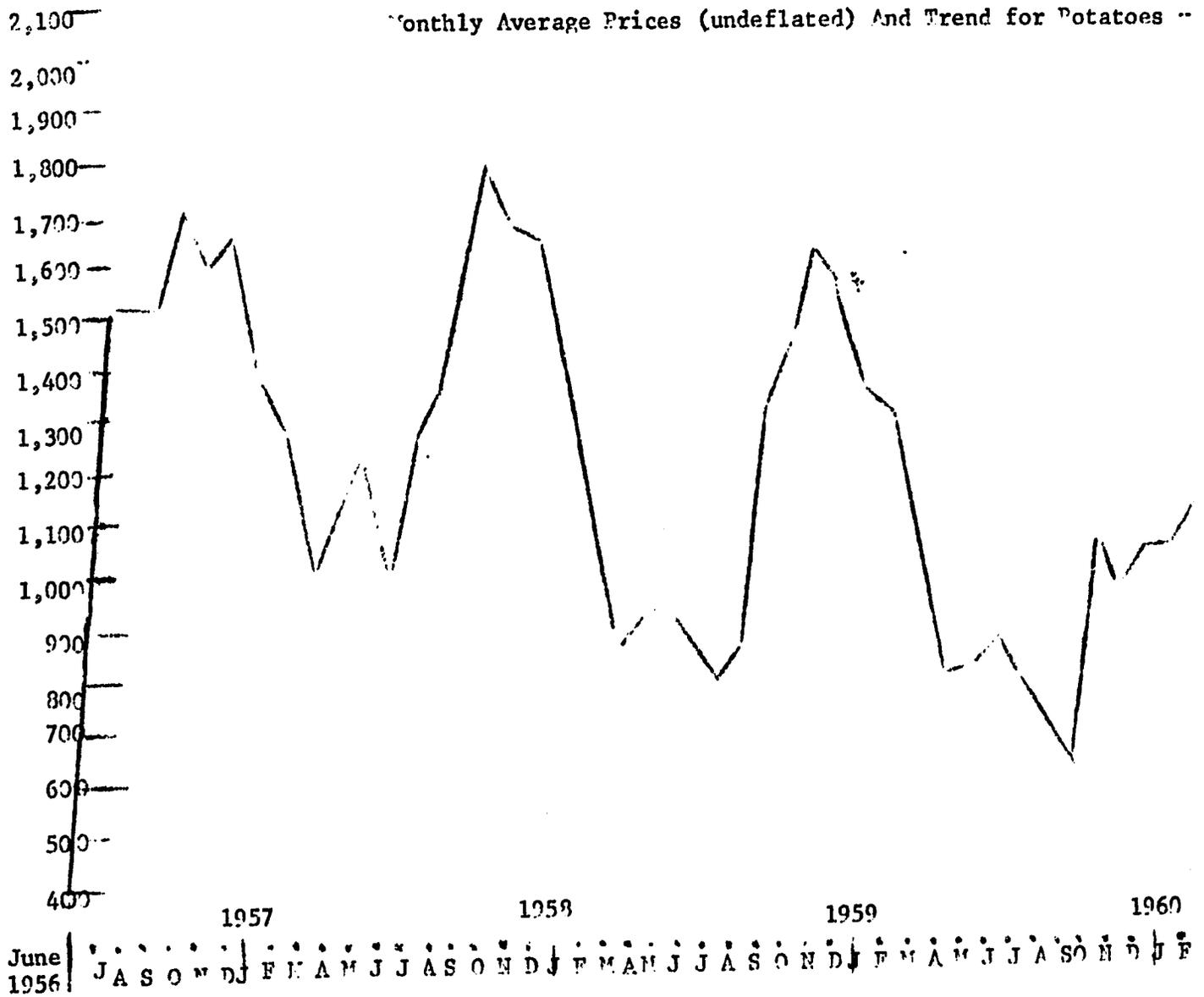
Seasonal Patterns

Figures 2 and 3 show the fluctuations in the monthly average retail potato prices in La Paz for two periods--Figure 2 for before the Agrarian Reform and Figure 3 for after.* These graphs, plus Figure 3a, show when the major arrivals of potatoes occur at the La Paz market. The price extremes are determined by the growing seasons in the primary supply areas for La Paz, while the variations between these extremes depend on supplies from other regions having different climatic patterns. A good example of this is seen in Figure 3, for the year April, 1958 to April, 1959. In April, the crop from the higher and main producing areas in the La Paz region arrives at market, and the first bottom price is reached. The price then begins to rise until winter "new" potatoes from warmer climates arrive in the market, and is then at a new bottom around August. The price then rises sharply to

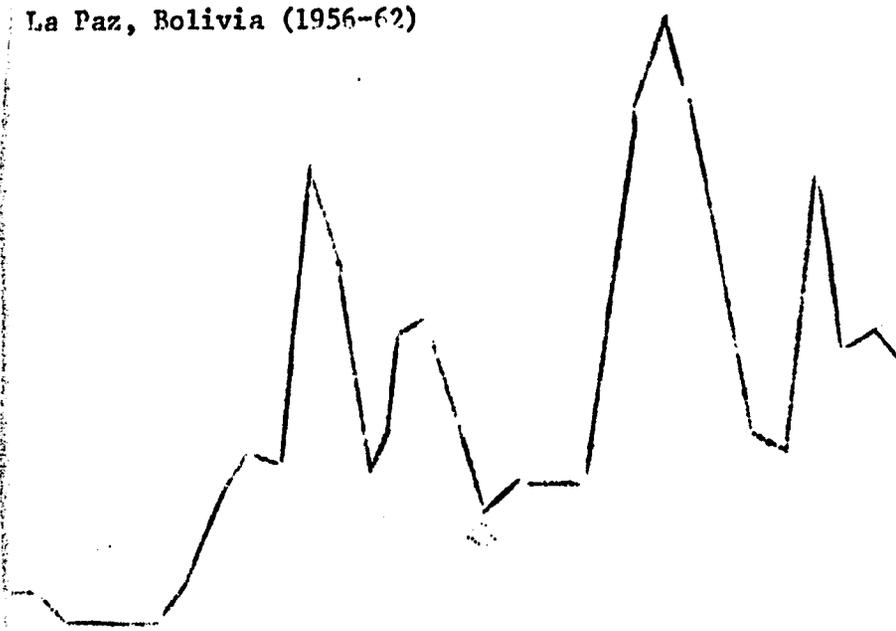
*Monthly data were available for only these two periods. They are plotted without adjustment for trend or changes in the general price level. The data were not deflated because monthly index numbers were not available. However, the data were adjusted for trend through dummy variable techniques in the seasonal variation analysis which follows.

Price,
Pesos Bolivianos
Per Kilo

Figure 3



La Paz, Bolivia (1956-62)



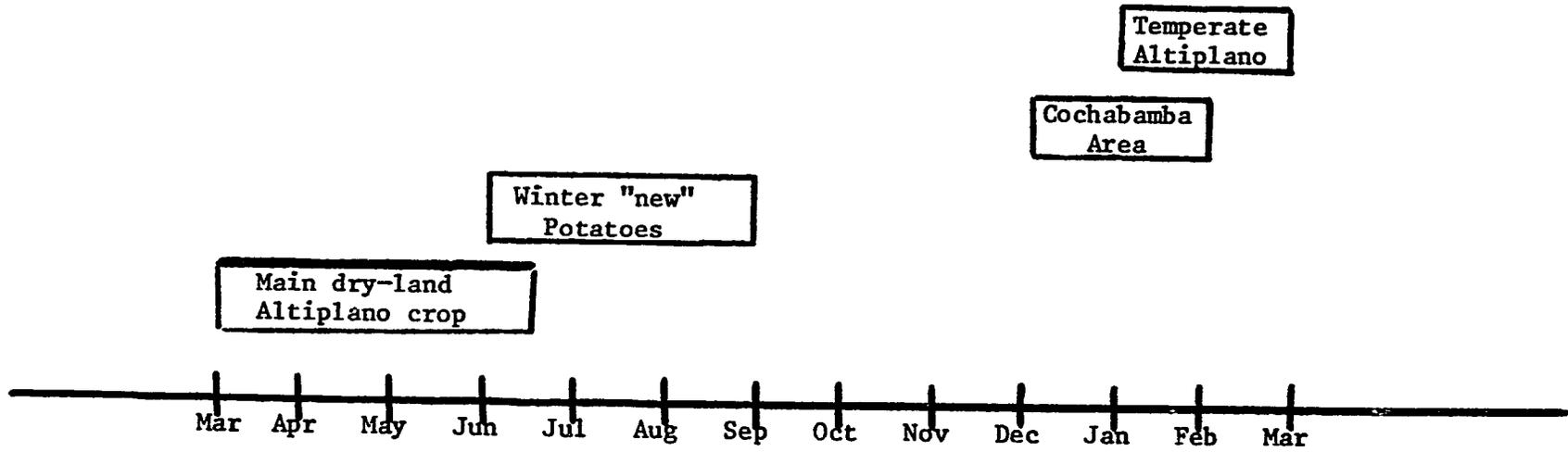
1961

1962

N A M J J A S O N D | F M A M J J A S O N D | F M A M J J A S O N D

Figure 3a

Potato Marketings in La Paz, Bolivia



December, reflecting months when essentially no potatoes are being harvested. After the peak price in December, a slight drop is observed. This is in response to arrivals from the main crop harvest in Cochabamba, a much lower and warmer region than La Paz. This crop continues to have an influence into February, when crops from the Altiplano (highland plateau region in which La Paz is located) again make their appearance, led by potatoes from the more temperate Lake Titicaca locale. Finally, the main dry-land Altiplano crop is again harvested, completing the yearly cycle.

Studies of seasonal patterns such as shown here are very useful to economic planners at all levels. They indicate the need for and suggest the location of storage facilities, for a concentration on transportation problems, and for general or directed credit. For Bolivia, especially, studies of change in seasonal patterns can give very important insights into the effects of the Agrarian Reform on market behavior and structure, particularly with respect to the effects on peasant farmers.

To determine whether the Agrarian Reform had any impact on the seasonal pattern of potato prices, seasonal indexes were calculated for two time periods, before and after the Reform.

The results are presented in Figures 4a and 4b, which show how the monthly prices index (solid lines) might be expected to vary over a typical year because of seasonal factors. The indexes were constructed by regressing monthly prices on monthly dummy variables. March was chosen as the base period, index = 100, from which seasonal variation is measured.

Each figure also contains lines drawn on both sides of the average index line at a distance of two standard deviations (2 σ) of each monthly price

index. These lines represent the limits within which the indexes for each month may be expected to vary approximately 95 percent of the time. Significant seasonal variation would exist whenever the index = 100 falls outside these limits. Such a situation would mean that the seasonal index for that month would differ significantly from an index of 100, the average for the year.

As seen in Figure 4a, the period 1941-45 shows no significant seasonal variation, implying that for those years retail potato prices in La Paz would not be expected, with any reasonable degree of certainty, to vary throughout the year. However, for the period 1956-62, the opposite is true. Here a definite seasonal pattern exists, with seasonal highs occurring in the November to January period and the seasonal low occurring in July. Thus, it appears that a significant structural shift in the seasonal patterns of potato prices occurred during the 1941 to 1962 period.

The basis for seasonal variation in the price of agricultural commodities lies in the growing season and the weather, coupled with certain market factors which may reinforce this pattern. In Bolivia, the presence of significant seasonal variation in the 1952-62 period versus none in the earlier period may be attributed to several reasons that are either directly or indirectly associated with changes caused by the Agrarian Reform. In the earlier period (1941-45) almost all agricultural production for market was in the hands of a relatively small number of large and medium-sized landowners who individually and collectively made attempts not to saturate the markets at harvest time. These landowners had their own storage facilities which permitted them to regulate the flow of potatoes to the market. Such practices

Figure 4a: Seasonal Variation of Monthly Price Indexes, La Paz, Bolivia
(1941-1945)

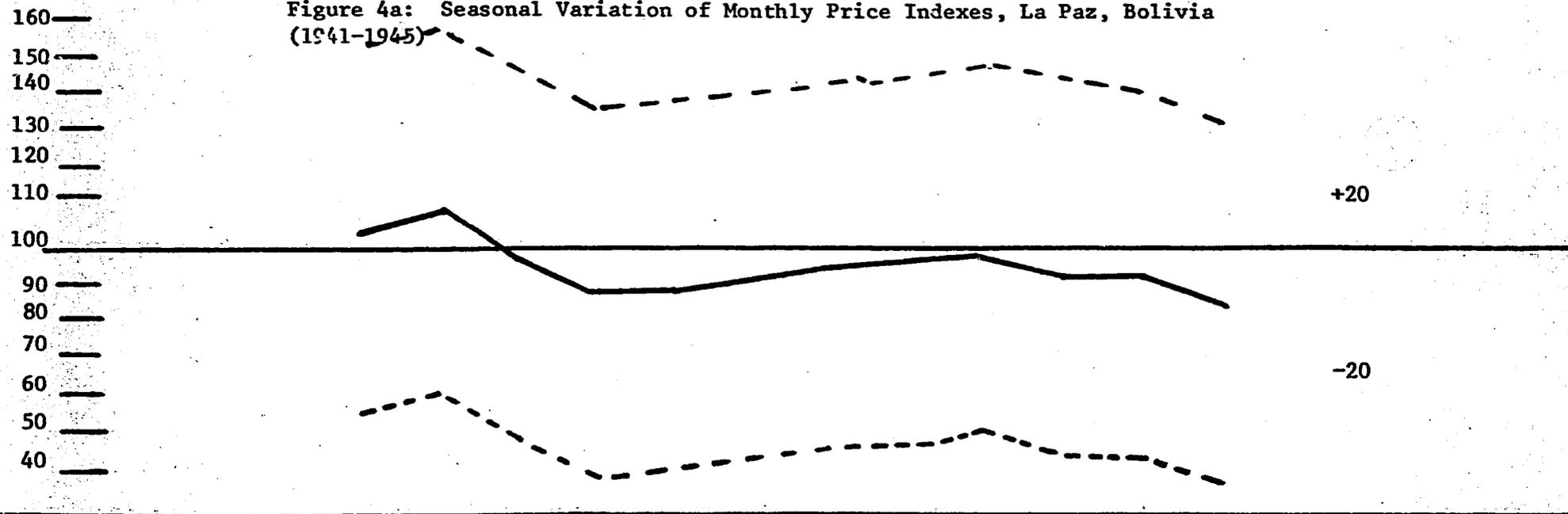
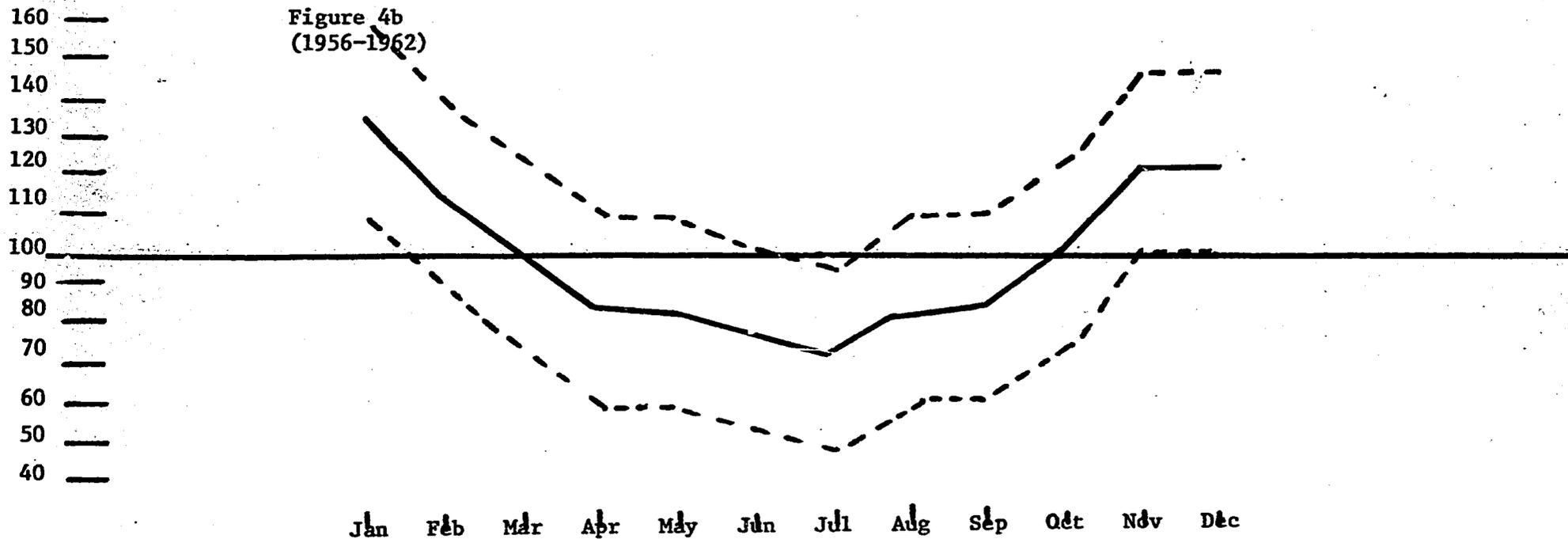


Figure 4b
(1956-1962)



tend to smooth out seasonal fluctuations in price, resulting in less extreme prices at both peaks and bottoms.

The latter time period (1956-62), on the other hand, covers the period immediately after the Agrarian Reform, through which most peasants became landowners. As the peasants began to market their produce on a small scale, a situation very close to perfect competition and a free market resulted. This was reinforced by an almost total lack of private, commercial, or cooperative storage facilities which would have permitted some control over the rate of flow to market. Currently, some local development projects are attempting to alleviate this problem. In addition, until recently, a lack of sufficient transportation has not allowed supplies to move to the markets where higher prices prevail. Finally, departmental and provincial authorities (comparable to state and county officials in the U.S.) often attempt to prevent the free movement of potato supplies between regions on the pretext of keeping the price low in their own areas in order to benefit the consumers.

The above analysis of seasonal variation suggests that the contention of a significant structural change in the market system from pre-Agrarian Reform Bolivia to post-Agrarian Reform Bolivia is valid, at least for potatoes. However, the analysis also suggests that although the peasant is now essentially free from his previous serf-like condition, has more land to use as he wishes, and has more agricultural surplus to sell, he has become subject to the vagaries of the market and cannot be sure of realizing a profit from what he may sell of his most important crop. Further study of this market is

needed in order to determine what additional programs may be needed in order to assist the peasant to adjust to a market economy.

Factors Affecting the Price of Potatoes

A proposed structure of the potato market in Bolivia is depicted in Figure 5. The development of this flow chart drew upon relevant economic concepts, previous research on potato markets (particularly Hee [17]), and the author's experience in Bolivia as a Peace Corps worker involved in agricultural extension work with potatoes. The suggested divisions are based almost entirely on the author's knowledge of the Bolivian economy, agriculture, and consumption habits.

The basic hypothesis continues to be that the Agrarian Reform contributed to a structural change in the market, which will be investigated in this section by an analysis of some of the major factors affecting the price of potatoes.

Many of the variables shown in Figure 5 were not included in the analysis primarily because of the lack of readily available data. Some interesting and relevant variables not examined specifically include redistribution of lands, improved technology and its wider use, the effects of government programs, and the expansion of the transportation system. The demand for potatoes for use as seed could also be profitably included, but reliable figures were not to be found.

The independent variables used in the analysis are the per capita dollar value of tin export earnings as an income proxy, the price of rice as representative of the general category of the prices of substitutes, and per capita potato production.

The value of tin export earnings was used as an income proxy because it appears to be highly correlated with the available national income figure. Tin export earnings were chosen because they are a much more complete, reliable, and consistent set of data. In addition, mineral exports account for most of Bolivia's export earnings and tin generally comprises 70% or more of this. The tin mining and processing sector has been and is a great urbanization factor and one of the largest single employers. And because of the nationalization of the largest mines after 1952, accompanied by government commitment to mine workers and peasants and the creation of a large public agency to operate these mines, a greater percentage of the earnings goes to the government and more is dispersed in the form of wages and development spending.

The expectation of the behavior of the income proxy variable is either that as export earnings rise so will the demand for potatoes because of increased income and urban concentration caused by increased employment in the mining sector, or more likely, as employment and income rise, the demand for potatoes will fall because the potato is an inferior good, meaning that people will substitute other commodities for potatoes as income rises.* The expectation for the price substitutes is that the prices of rice and

*Because of the use here of a previously untested income proxy, the reader may be justified in not placing heavy reliance on the magnitudes of the results connected with this variable. The author feels, however, that this is not a major difficulty for this study, and that the general results are valid.

potatoes will move in the same direction, conforming to the economic definition of substitute goods. For the third independent variable, the price of potatoes is expected to decrease as the quantity of potatoes produced per capita increases

The form of the basic equation to be estimated is as follows:

$$Y = b_0 + b_1X_1 + b_2X_2 + b_3X_3 + e,$$

where Y = price in bolivianos of potatoes per kilogram, deflated by the general cost of living index, 1931 = 100,

X₁ = per capita dollar value of tin export earnings,

X₂ = price in bolivianos of rice per kilogram, deflated by the general cost of living index, 1931 = 100,

X₃ = per capita production of potatoes, in kilograms.

Regressions were run in the above form on the data sets for the years before and after 1952. For 1944-52, the result was (with standard errors in parentheses):

$$Y = .581 - .012X_1 + .081X_2 - .00013X_3$$

(.204) (.004) (.325) (.00006)

$$R^2 = .70$$

For 1955-65 the equation was:

$$Y = .555 - .009X_1 + .109X_2 - .00010X_3$$

(.190) (.006) (.187) (.00003)

$$R^2 = .66$$

The first equation was significant at the 15 percent level, while the second was significant at the 5 percent level.

A statistical test* on these two equations showed that the data for both periods came from the same basic relation. That is, the effect of a

*J. Johnston. Econometric Methods. McGraw-Hill Book Company, Inc., New York, 1963. pp. 136-138.

change in an independent variable on the retail price of potatoes in La Paz is taken to be the same in both the pre- and post-Agrarian Reform periods. Therefore, the data can be pooled and analyzed as a single set. This was done, and the form of the regression set up as follows:

$$Y = b_0 + b_1Z + b_2X_1 + b_3X_2 + b_4X_3 + e,$$

where Z is a dummy variable for the pre-1952 constant term or intercept. The dummy variable was added as a test for significant difference between the constant terms for the two periods, the presence of which would indicate a structural change from one period to the next.* The other variables are as above.

The result was:

$$Y = .602 - .066Z - .012X_1 + .082X_2 - .00012X_3$$

(.105)	(.029)	(.003)	(.122)	(.00003)
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$$R^2 = .88$$

This analysis shows that there is a very definite relation between changes in the independent variables and a change in the retail price of potatoes in La Paz. Statistically, the relation is highly significant. The R^2 is also encouragingly high, indicating that the choice of variables is valid. The meaning of this R^2 statistic is that 88% of the change in the

*This procedure is justified because the test in Johnston is an F-test on the observations for all the variables, including the intercept, simultaneously. Therefore, one cannot conclude that the data on each variable, taken separately, come from the same relation as the other data sets. The dummy variable technique tests the intercept separately and indicates that the two time periods generate significantly different intercept terms.

retail price of potatoes is associated with changes in the independent variables.

Individually, the coefficients of the income and production variables (X_1 and X_3) are statistically significant at the 1% level, implying that the estimated effects of changes in these two variables on the price of potatoes are reliable. However, this cannot be said for the coefficient of the price of rice (X_2). Such a result may reflect the extent of this variable's intercorrelation with income and production, a result that must necessarily be expected. For example, with potato production up (down), the price of potatoes drops (rises), causing the price of rice to drop (rise), since rice is a substitute for potatoes. Another fact also points to strong intercorrelation among these variables. The estimate of the coefficient of the price of rice seems to be quite sensitive to changes in model specification and sample coverage. Such an occurrence is mentioned by Farrar and Glauber [15] as being a good indicator of high multicollinearity. Further investigation of variable form or model specification may help correct this problem.

The signs of the coefficients of the independent variables are in conformity with expectations. The price of rice is seen to move in the same direction as that of potatoes, indicating that the two are substitutes, and the price of potatoes moves opposite to the per capita production of potatoes. The negative sign on the coefficient for the per capita income proxy is most noteworthy, and strongly suggests that the potato is an inferior good in Bolivia. This means that if per capita income continues to rise, the demand

for potatoes should weaken, and perhaps even decline, if enough substitutes are available. Further study to determine the exact nature of this aspect is necessary.

Additional information on the relations between these variables can be obtained from the above regression results in the form of price flexibilities. These show the percentage change in the retail price of potatoes resulting from a 1% change in each of the independent variables, the other being held constant. Such measures, expressed in percentage form, are more indicative of the magnitudes of the effects of the variables than are the coefficients of the variables, since they are independent of any unit of measurement. In this case, the retail potato price flexibility with respect to

per capita income = $-.70$;

the price of rice = $.16$;

per capita potato production = $-.43$.

The interpretation of these figures is that a 1% rise in the per capita income proxy variable will result in a .7% drop in the potato price, and similarly for the price of rice and per capita production.

Finally, the above regression result provides further support for the contention that there has been an important change in the market structure since the institution of the Agrarian Reform. The coefficient of the dummy variable, introduced to test for such a structural change, tested statistically significant at the 4% level. This means that the linear regression line for the estimated retail potato price for the pre-Agrarian Reform period is

shifted down by .066 bolivianos. Therefore, a shift upward in the basic level of the deflated retail potato price is the only change in the relation between these variables determined to have occurred since the Agrarian Reform. Perhaps this change can be attributed to a basically stronger urban demand resulting from a 73% larger total urban population in 1965 than in 1950. Although the author could not find this break-down for La Paz alone, its urban growth percentage can reasonably be assumed to be at least as high as the overall growth.

Some Conclusions and Policy Suggestions

This paper has had two main purposes—to determine and analyze some of the basic structural relations in the La Paz potato market and to examine the effects of the Agrarian Reform on this structure. From the standpoint of these two purposes, important economic results supported by statistical significance have been obtained. A third purpose also becomes implicit in such a paper, namely, to use the results of the analysis to suggest policies consonant with the development goals of Bolivia.

The analysis of seasonal price fluctuations gives strong empirical and statistical verification to an observed problem. It also shows very clearly that, since the Agrarian Reform, seasonal variation has increased significantly. The probable reason for this is that the Agrarian Reform created thousands of individual sellers, resulting in a free market situation where before there was only a relatively small number of sellers, which made tacit and overt collusion more likely.

One possible solution to this problem may be the creation of storage facilities that are financially and geographically accessible to the peasant farmer. Another may be a government purchase and storage program, although the perishable nature of potatoes would make such a program difficult. Government action to ensure free movement of produce between areas of high supply and high demand is a third possibility. Further support to the cooperative movement could be given to allow collective selling, which would enable groups of peasants to acquire their own storage and/or transportation equipment and to provide the needed technical advice. In addition, general and directed credit could be employed to make it financially possible for peasants to postpone marketing of their produce until more favorable conditions exist.

The analysis of the factors affecting the price of potatoes has shown some basic characteristics of the potato market that are important from the economic and policy-planning points of view, and quite defensible from a statistical standpoint. The coefficients of income, rice, and production behave according to expectations, and the price flexibility of each gives an idea of the magnitude of their respective effects.

The suggestions of the economic inferiority of the potato, by reason of a negative coefficient for the income variable, and also the marked and recently increased downward long-run trend, have noteworthy policy implications. Two directions for such policies seem to be indicated. One is that too many scarce development resources should not be directed toward potatoes. The second is that a reasonable amount be directed toward research

on the potato and its market, and on the crucial point of dissemination of the results. This would allow the nation to meet its needs with a better quality, and thereby more profitable product, using less land, and with less effort. The hoped-for result of such a program would be to encourage and permit expansion into more profitable cash crops once the peasant and urban population are assured the traditional basic food supply.

It is hoped that this study, by no means definitive, emphasizes the fact that empirical and statistical analyses of economic data have an important place in the formation of policies in the developing countries. The reasons in this case are that the potato plays a large economic and cultural role in Bolivia, and that since the Revolution and Agrarian Reform of 1952-53, the Bolivian peasant has been taking an increasingly active part in the national market economy. Thus, study of the crop that uses a considerable proportion of the peasant's most valuable resources is imperative.

APPENDIX

Derivation of Prices for 1946-50

Price indexes for potatoes and rice for 1946-50 were obtained from Estadísticas de Índices de Precios de Productos Agropecuarios de Bolivia (Ministerio de Agricultura, Ganadería, y Colonización - 1945-50). The 1945 retail prices of potatoes and rice were taken from the series contained in the Boletín of the Banco Central de Bolivia. The prices for 1946-50 were then derived by multiplying the 1945 price of each good by its price index divided by 100 for each year.

Derivation of Deflated Prices

All prices, including those derived for 1946-50 were deflated by dividing the average price for each year by the general cost of living index for that year, 1931 = 100.

Derivation of Population Figures for 1944-51

The 1950 population census figure of 3,013,000 was used as the basis for these derivations. A constant 2% growth rate was assumed. This was based on data contained in the USAID/Bolivia "Red Book" No. 10 [24], which gives population growth rates for 1950-55 at 1.98%, and for 1955-60 as 2.16%. The estimated yearly populations for 1944-49 were derived from the formula

$$X_i = \frac{P_i}{1.02}$$

where i = the population for the years 1949, . . ., 1944,
and j = the populations for the years 1950, . . ., 1945.

The 1951 population figure was the only one that had to be derived forward. It was derived by multiplying 1.98 by 3,013,000.

Derivation of the general cost of living index for 1963-66, 1931 = 100

The continuous general cost of living index series for La Paz, 1931 = 100, ended with 1962. To obtain a continuation of the same series for later years, the index number for 1958, series 1931 = 100 was multiplied by the index number divided by 100 from the series 1958 = 100 for each of the years 1963-66.

As a check for accuracy, this was done for years earlier than 1963, and the average difference between the original series number and the derived index number was about 2 percent.

Potato Production Figures

A relatively consistent series for production was derived by considering the data obtained from all sources. When there was a disagreement between sources on production for a particular year, the figure that was used by more than one source, or that figure which was part of the longer internally consistent series was chosen. When only one figure was available for a particular year, it was used.

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