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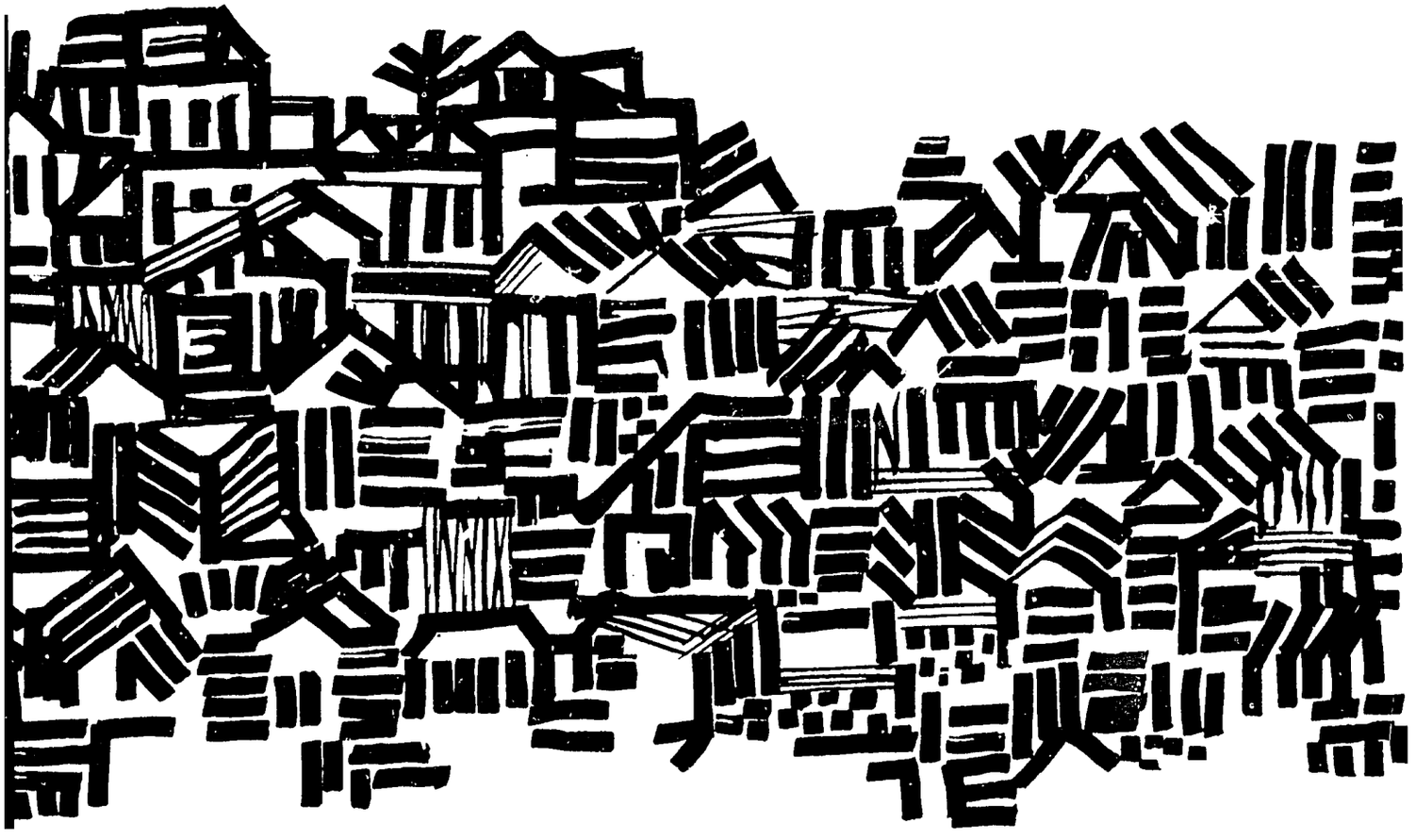

GRADUATE SCHOOL OF BUSINESS ADMINISTRATION • UNIVERSITY OF CALIFORNIA, LOS ANGELES

EFFECTS OF HOUSING ON HEALTH AND PRODUCTIVITY: ZACAPU, MEXICO

by

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International Housing Productivity Study
Housing, Real Estate, and Urban Land Studies Program
Graduate School of Business Administration
University of California, Los Angeles

October, 1968

PRELIMINARY

INTERNATIONAL HOUSING PRODUCTIVITY STUDY
GRADUATE SCHOOL OF BUSINESS ADMINISTRATION
UNIVERSITY OF CALIFORNIA, LOS ANGELES

The International Housing Productivity Study is a major research effort which seeks to articulate the position of housing in economic development programs. International studies are supported by a research contract with the Agency for International Development, U. S. Department of State; domestic studies are supported by a research grant from the National Center for Urban and Industrial Health, U. S. Public Health Service. Papers and reports dealing with various aspects of the research will be published periodically.

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TABLE OF CONTENTS

	Page
LIST OF TABLES AND FIGURES	iv
ACKNOWLEDGMENTS	v
ABSTRACT	vi
SECTION	
I. INTRODUCTION	1
II. CHARACTERISTICS OF THE TEST SITE	4
Initiation of the Project	5
The Project Today	7
The Flood	10
III. EXPERIMENTAL DESIGN AND SITE SELECTION	12
Criteria for a "Controlled Experiment"	12
Site Selection and Data Collection	19
IV. THE HOUSING AND PRODUCTIVITY RELATIONSHIP	21
V. THE HOUSING AND HEALTH RELATIONSHIP	28
Rehousing and Absenteeism	28
Rehousing and the Demand for Medical Care	31
Absenteeism as a Measure of Health	33
VI. HOUSING AND HEALTH: ISOLATING A CAUSAL RELATIONSHIP	47
Housing Quality Change and Absenteeism	48
Housing Quality Change and Outpatient Visits	51
Components of Housing Quality Change	52
VII. SUMMARY -- REHOUSING AND BEHAVIOR	59
BIBLIOGRAPHY	65
APPENDIX I Zacapu Questionnaire	67

TABLE OF CONTENTS (Cont'd.)

SECTION		Page
APPENDIX II	Levels of Health and Absenteeism in Zacapu	76
APPENDIX III	Zacapu in the Mexican Housing Census	83
APPENDIX IV	Statistical Calculations	84
APPENDIX V	Correlation Matrix for Housing Quality Variables .	87

LIST OF TABLES AND FIGURES

Table		Page
1	Productivity Bonuses	22
2	Mean Yearly Absences per Person Attributed to Illness	29
3	Outpatient Visits and Inpatient Days at Social Security Clinic	32
4	Actual Versus Expected Absences (1964-1967)	36
5	Outpatient Visits Classified by Disease Group	79

Figures

1	Housing Project Photographs	8
2	Graphical Illustration of Hypothesis III	39
3	Housing Quality Variables	49
4	Housing and Health Mechanisms	55

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ABSTRACT

This study is an empirical investigation of the return to housing as an investment in human capital. It analyzes the effects of a substantial improvement in housing quality on the health and productivity of a group of industrial workers in Zacapu, Mexico. Two measures of health, work absences attributed to illness and visits to a free medical facility, are presented for a group of 50 workers (n = 46 for medical data) for two years before and two years after their rehousing in a company sponsored project of modern single family dwellings. A control group of 50 non-rehoused workers from the same plant is used to hold constant changes in the non-housing environment. Changes in productivity bonuses are studied for matched groups of 10 rehoused and 10 non-rehoused workers.

During the first year after rehousing, rehoused workers experienced a significant increase in productivity as well as an unexpected increase in absences. The increased absenteeism was not accompanied by an increase in visits to the medical facility. It is hypothesized that rehousing raised workers' marginal productivity in making various home improvements, causing them to feign illness in order to work around the home. The increase in productivity on the job is attributed to an adjustment to this higher productivity in the "household sector". Both productivity and absenteeism returned to their pre-rehousing levels after the initial post-rehousing year. The study fails to find a substantial and permanent stream of benefits accruing to the "investing" firm.

The study investigates the relation of changes in the two health measures to 14 variables representing changes in various aspects of housing quality. Persons who experienced an elimination of rat infestation are found to have made fewer clinic visits after rehousing than those who did not experience this improvement. The study presents evidence as to the reliability of reported absenteeism as a measure of health and briefly summarizes changes in the incidence of specific diseases among rehoused workers, finding post-rehousing reductions in infective and parasitic diseases and diseases of the digestive system.

I. INTRODUCTION

This study is an empirical test of the assertion that better housing can be used as a tool for raising the productivity and improving the health of workers in less developed countries.[1] It tests the proposition that improvements in housing can raise either the capacity to work or the desire to work, resulting in greater output per manhour and lower absenteeism. The study investigates the effects of housing on two crude measures of health and attempts to isolate those features of improved housing which have the greatest impact on those measures. It also seeks to determine whether housing generates benefits which may be captured by a firm "investing" in housing for its workers.

It is intuitively, as well as empirically, clear that positive simple correlations exist between housing and health and housing and productivity.[2] The direction of cause and effect, however, is uncertain. High productivity and good health lead to high incomes. Since the income elasticity of demand for housing is positive, the worker will use part of this additional income to improve the quality

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[1]The report is a case study of the International Housing Productivity Study, a research project supported by the Agency for International Development, U.S. Department of State. The Study is concerned with measuring the effects of improved housing on health and productivity at test sites in several countries.

[2]A study of 83 English County Boroughs (1929-33), for example, showed a simple correlation of .771 ± .030 between the standardized mortality ratio and an index of housing quality. Cf. Great Britain, Registrar-General, Statistical Review of England and Wales for the

of his housing.[3] Thus the healthy and highly productive individual will tend to reside in housing of higher than average quality. More difficult to prove, however, is a particular direction of causation: that an improvement in housing quality itself will raise productivity and improve health.[4] This study attempts to isolate the effects of housing from those of other factors which influence health and productivity by imposing a rigid set of conditions on the test site.

Year 1934, p. 151. A survey of the housing/health literature may be found in A. E. Martin "Environment, Housing and Health" Urban Studies, Vol. 4, No. 1 (1967). An extensive bibliography on the subject is contained in Alvin L. Schorr, Slums and Social Insecurity, Research Report No. 1, Division of Research and Statistics, Social Security Administration, U.S. Department of Health, Education, and Welfare, (1963).

To some extent, income may be taken as an approximation to productivity. Poor housing is generally, although not inevitably, associated with low income people. In Mexico, for example, 68 percent of urban families having monthly incomes of 1000 to 3000 pesos have housing with private toilet facilities. Among urban families with monthly income less than 300 pesos, only 14 percent have such facilities. Mexico, Instituto Nacional de la Vivienda, Investigacion Nacional de la Vivienda Mexicana, (1963) p. 73.

[3]The income elasticity of demand for housing in the United States in 1950 was estimated at .605. Sherman J. Maisel and Louis Winnick "Family Housing Expenditures--Elusive Laws and Intrusive Variances" in Wheaton, et al., Urban Housing (1966), p. 146. The Banco de Mexico estimates the income elasticity of demand for rental housing (1963) at .888 for urban areas and 1.37 for the nation as a whole. (Unpublished budget survey courtesy of Sr. Leopoldo Solis, Departamento de Estudios Economicos, Banco de Mexico).

[4]Earlier IHPS studies of housing projects in Pine Ridge, South Dakota and Hambaek, Korea, have pointed to positive effects of housing improvements on both health and productivity. Cf. Leland S. Burns, "Cost-benefit Analysis of a Social Overhead Project for Regional Development," Papers of the Regional Science Association, European Congress, Cracow, 1965, and Leland S. Burns and B. Khing Tjioe, "Housing and Human Resource Development," Journal of the American Institute of Planners Vol. XXXIV, No. 6, November, 1968.

The report analyzes the experience of 50 employees of an artificial fiber plant in Zacapu, Mexico, two years before and two years after a substantial housing improvement. In November 1965 the workers moved from rented housing of widely varying quality to a tract of modern single family dwellings. The new houses were of three types, differing only in lot size and number of bedrooms. All had running water, electrical outlets in all rooms, a separate kitchen, bathroom with WC and shower, and a water heater. The previous houses were mainly adobe or plastered brick buildings with common walls and no setback from the street. The rooms communicated with a central patio rather than with each other. Many services found in the new houses were absent in the old. In general, the workers moved from "typical" high density Mexican urban housing to a modern tract with many of the characteristics of a rather low quality development in the suburban U.S.

II. CHARACTERISTICS OF THE TEST SITE

Zacapu is a town of 25,000 in the heavily forested state of Michoacan, about 230 miles west of Mexico City. It lies in a fertile agricultural valley dominated by the western spur of the great Sierra Madre mountain range. While the major product of Michoacan is corn; that of Zacapu is rayon fiber. Good rail transportation and a plentiful water supply prompted Celanese Mexicana, S.A., to construct an artificial fiber plant in Zacapu in 1948. The plant converts Canadian wood pulp and Mexican cotton into rayon fiber for the textile industry, rayon tire cord and cellophane. Located about two miles from the center of town, the plant is Zacapu's major employer, currently employing 346 white collar and 1,113 production workers. Although there are two other factories in town the Celanese plant is the major force in Zacapu's economy, its commerce and its charities.

The rapid expansion of the Celanese plant over the past 20 years has stimulated commerce and population growth in Zacapu. The urban population of the municipio of Zacapu rose from 6,169 in 1940 to 14,349 in 1950 and 24,770 in 1960. There are now nine primary schools, a new (1965) secondary school and a vocational school. A modern clinic has been constructed by the Instituto Mexicano del Seguro Social and a sanitary produce market was dedicated by Mexican President Gustavo Diaz Ordaz in 1965. The town's progress is symbolized by the

renovation last year of the town square, in a style less Mexican than reminiscent of an American shopping mall.

Another symbol of Zacapu's progress was a housing shortage. The rapid population increase placed strains on the housing supply and pressures on rents. Although the workers in this study are relatively well off by Mexican standards, they were sometimes forced to live in low quality housing because of the lack of housing even at high rents. Anticipating union pressure for a company housing program, Celanese Mexicana purchased a tract of farmland on the edge of town and constructed a 76 house development called "Loma Jardin".

Initiation of the Project

Loma Jardin (literally "hill garden") began in early 1965 with distribution of a questionnaire and housing information to all Celanese workers. Seventy-six persons had sufficient interest and resources. All but one were employed by the plant, the exception being the son of a Celanese worker. The rehoused group was divided about 60/40 between production workers and white collar workers, the latter including laboratory technicians, office workers and engineers.

The housing was offered for sale on quite favorable terms. A mortgage term of 15 years was provided at nine percent interest. Both the term and the interest rate were the best available in the Mexican housing market. A life insurance policy was an adjunct to the mortgage, providing for automatic payment in full upon the death of the head of the house. Several of the residents have commented favorably about this provision. The project's major attraction, however, was

the absence of the usual 20 percent downpayment. The company subsidized the purchase of the land, making it possible for "Loma Jardin" residents to obtain the equivalent of a 100 percent loan from the Banco Nacional de Mexico. Among people who do not have what a Celanese executive calls "the saving habit" the downpayment had represented the major obstacle to homeownership. Now the only requirement was that the worker be "solid en trabajo", a steady worker. When asked why they had moved to their new homes over 80 percent of Loma Jardin residents answered that the method of payment provided them with an unequalled opportunity for homeownership and equity building. The recurring phrase is "pago como renta" -- "I pay the mortgage like rent."

Monthly payments, including principal, interest and insurance, are 285 pesos (1 peso = $.08 U.S.) for a two bedroom house, 347 pesos for a three bedroom, and 398 pesos for a four bedroom. The 76 houses in Loma Jardin are about equally divided among these three types. The actual building was undertaken by Construccion Popular, S.A., a large Guadalajara firm which specializes in low cost housing. Construccion Popular is currently erecting a similar development for workers at the Celanese plant in Ocotlan, Jalisco, about 100 miles from Zacapu.

The major building materials were cement and fired clay bricks, the latter made on-site in temporary kilns. Because of Zacapu's relative isolation and the consequent need to import construction labor and materials from outside the immediate area, the construction company does not regard the project as very profitable. Early in 1968, Celanese considered adding to the project and received about 50

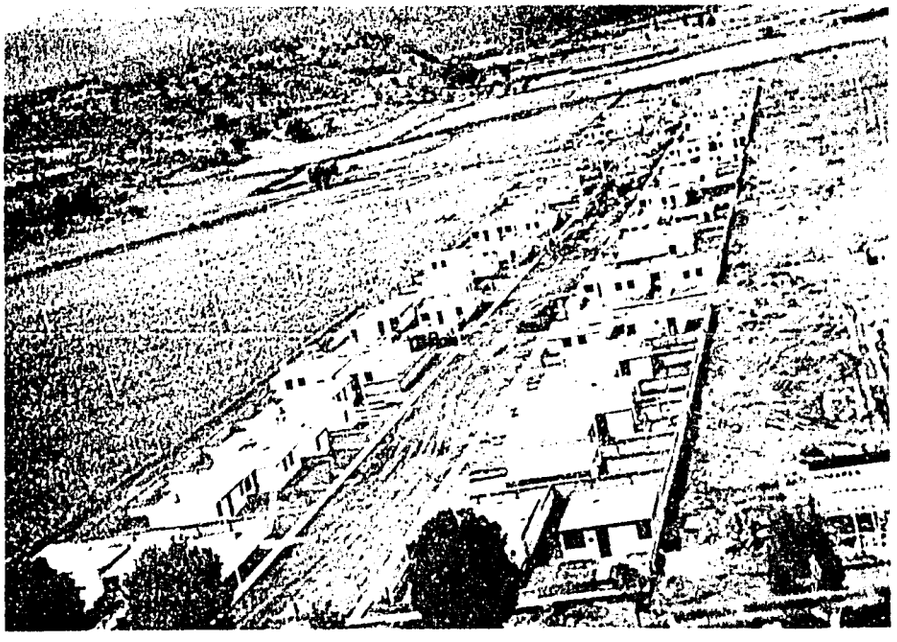
applications from workers. As of this writing, the addition was being held up by rises in the costs of hand labor and building materials.

The Project Today

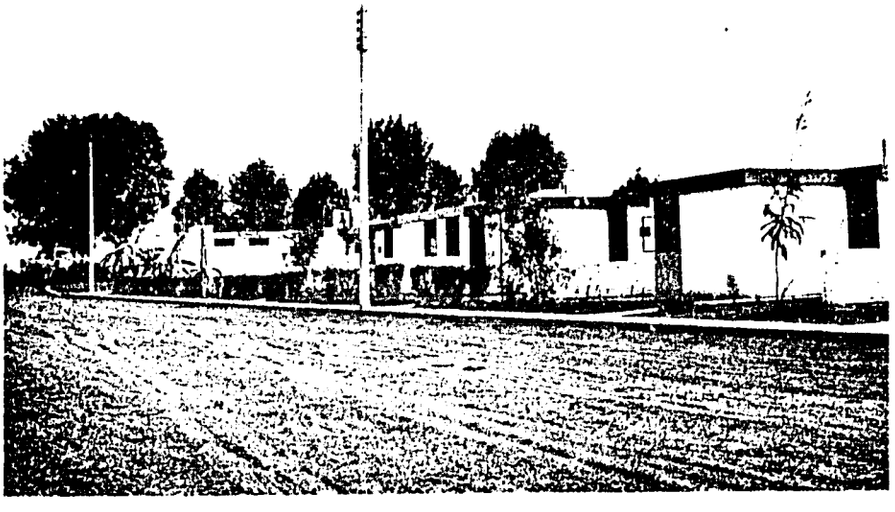
Loma Jardin was dedicated by the President of Mexico in October 1965 and was occupied in October and November of that year. It currently consists of a single five block long main street, cut by very short side streets. (See Figure I for photographs). There are concrete sidewalks and adequate curbs, although the streets are of lightly asphalted gravel and less than completely smooth. The houses have already been differentiated by their owners. Small grocery stores have been added onto the front of two of the homes and have developed into neighborhood gathering places. Another resident maintains a radio repair shop in his home in his spare time. One woman retails chickens which are raised on a relative's farm.

The distance from town is the major complaint of residents. Although the project is really only a half mile from the edge of town and a mile from its center, Loma Jardin residents feel isolated. Few have automobiles and the local bus service, though fairly frequent, is very irregular. Transportation to the Celanese plant and to the schools is provided by buses owned by the labor union and is considered satisfactory. Wives, however, miss the convenience to church and the market which they enjoyed when they lived "in town". Social life seems to have become centered on the neighborhood itself. Women feel closer to their neighbors because, as one remarked, "We depend on each other more now," for transportation, child care, and the social exchange formerly

Figure 1



"Loma Jardin" under construction, August 1965



"Loma Jardin" shortly after completion

provided by relatives. Loma Jardin residents plan to build a church and shopping area on the vacant block on the main street. The completion of this project and the possible expansion of the number of homes may reduce complaints of isolation. Already property values have skyrocketed and the expansion of Zacapu seems to be toward Loma Jardin and Colonia Moderna, another subdivision on the same side of town.

The project is very neat and orderly. Garbage is collected daily and there is little of the decaying smell which seems endemic to Mexican towns. There are many flies in evidence, but fewer, residents say, than in town. Field mice often enter houses from the plowed fields which surround the project but only one resident complains of rats. In town, however, rats are a major problem. Some of the town residents keep pigs and the corn which is stored for feed quickly becomes infested. Loma Jardin residents, however, do not keep pigs themselves and are geographically isolated from those kept in town.

The project's setting is magnificent. The plowed fields which surround the tract on three sides give way to hills dotted with adobe houses and finally to mountains. These are dominated by Tecolote, a massive green peak ringed with clouds. Residents have taken up the suggestion implied in the project's title and flowers are carefully tended in nearly every yard. The streets continue the theme, starting with the main street, Avenida Primavera ("spring"). There is something very "suburban" about Loma Jardin, perhaps because of the architecture of the buildings and the age structure of the residents. The average age of males in the colony is about 35-40 and few old people are seen.

Many of the residents have purchased houses larger than presently needed in anticipation of a growing family. Almost every house boasts a television antenna.

It must be emphasized that these are not poor people. Most have been employed by Celanese for 15 years or more and skilled workers predominate. The average monthly income is US $140 for production workers and US $200 for white collar workers. Even the lower figure places the Celanese workers in the top seven percent of Mexican industrial workers.[1] As noted above, however, the housing shortage in Zacapu forced many of them to live in fairly low quality housing before their relocation.

The Flood

Although living conditions in Loma Jardin are substantially better than those in town, an exogenous influence during July, August and September 1966 reduced the quality of life in about 40 percent of the colony. The engineers had selected a low lying site for Loma Jardin, neglecting to consider the heavy summer rains. The lower two fifths of the colony were recurrently flooded for three months. The water was only 6-12 inches deep but sufficient to cover sidewalks and dampen some houses. Angry complaints to Celanese caused the company to construct a concrete drainage ditch around the project. It was completed in June 1967 at a cost of 98,000 pesos. The cost was divided among the company, the owner of the adjoining land, and the residents, each of the latter contributing 114 pesos. The ditch worked well

[1] Novedades, June 12, 1965.

during the first summer rains of 1967 and little resentment remains even among those most affected by the flood.

Nevertheless, the flood was an exogenous influence on health and one peculiar to Loma Jardin. The town of Zacapu lies on high ground and was not flooded. Thus the quality of the environment of Loma Jardin residents declined during part of the measurement period relative to that of town dwellers. The improvement in housing afforded by the new colony was offset in part by the flood.

III. EXPERIMENTAL DESIGN AND SITE SELECTION

As noted above, it is difficult to separate cause and effect in the housing and health/productivity relationship. In addition, it is obvious that productivity and absenteeism are influenced by factors other than housing. Even if rehousing raises productivity, its effects may be swamped by simultaneous changes in the capital/labor ratio, by technological change or by changing average hours worked. Similarly, health may be changed by public health programs or by improved medical care. During the same week in which Loma Jardin was dedicated, for example, a new sanitary produce market was opened in Zacapu. In order to account for such influences a "controlled experiment" was conducted in an effort to hold constant all independent variables except housing change.

Criteria for a "Controlled Experiment"

The following conditions, common to all the IHPS studies, were imposed on the test site:

(1) The production process must be in operation before, during and after a sudden qualitative improvement in housing.

The Celanese plant has been in production throughout the period covered by the study. This includes the pre-rehousing period, calendar 1964 and 1965, and the post-rehousing period, calendar 1966 and 1967. The sudden change in housing occurred in October and November 1965. It

was considered advisable a priori to allow a brief adjustment period and the date of rehousing for analytical purposes is taken as January 1, 1966.

(2) The income effect must be absent or amenable to control.

In order to satisfy this condition the improvement in housing must be a result not of a previous increase in productivity, and hence income, but of some exogenous force. The offer of better housing, while subject to an "ability to pay" limitation, was the result of company beneficience (or company prescience) and not a reward for current productivity. Once rehoused, the worker did not have to maintain some specified level of productivity as a condition of continued residence. The company is not a party to the mortgage between the bank and the workers and hence has no coercive power over worker occupancy.

The workers did experience another kind of "income effect," however, in the form of a potential capital gain. It has been estimated that the costs of building additional houses of the same type on the Loma Jardin site had risen by 35 percent between 1965 and 1967.[1] This fact and the rising price of developed land indicate that the potential resale value of the Loma Jardin houses may have risen substantially. A 35 percent rise would equal about 10,000 pesos per house, nearly five months wages for an average Loma Jardin resident. The housing subsidy (in the form of land and legal assistance) granted by the company amounted to an additional 2632 pesos per house, or another 1 1/2 months wages.

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[1]Personal communication from Sr. Abel Alcazar P., Industrial Relations, Celanese Mexicana, S.A., December 19, 1967.

Another possible windfall was the interest subsidy involved in the 9 percent loan obtained on the houses from the Banco Nacional de Mexico. The interest rate relevant for comparison here is that which must be paid by those who are in the business of renting out houses. The exact rate is difficult to determine but a 12 percent rate seems conservative in the light of alternative rates of interest observed in the Mexican capital market. The present value of the difference between 9 percent and 12 percent loans is 4260 pesos, or an additional 2 months wages.

The total windfall is thus about 8 1/2 months wages -- 1 1/2 due to the company subsidy, 5 due to the increased value of the home, and about 2 due to the interest subsidy. This increase in wealth, although it can be converted into current income only by selling or renting out the new house, may be expected to generate a flow of nonpecuniary advantages and may substitute for other types of saving. We may estimate the return to this stock of wealth at the "lending rate" which Loma Jardin residents could obtain on alternative forms of savings.[2] At 9 percent annually, the service flow from the total windfall gain is about 125 pesos monthly.

A possible problem arises from the fact that the monthly payments on the new houses are almost invariably higher than the rent which rehoused workers had paid for their former houses. The average payment is 351.64 pesos per month while previous rents averaged 214.50

[2]A number of Loma Jardin residents, when asked how they would invest hypothetical winnings of 5000 pesos from the National Lottery, indicated that they would buy mortgage bonds ("bonos hipotecarios"), which yield about 9 percent per annum.

pesos. The difference between present payment and former rent slightly exceeds the imputed service flow stemming from the capital gain. There was thus no possibility that lower payments would free current family income for non-housing expenditures (such as food and clothing) which could affect health and productivity. There is some slight chance, in fact, that the opposite may have happened and higher payments caused a cut in non-housing current outlay. This point will be elaborated and tested statistically in Section VI.

As will be detailed in Section V, the unexpected addition to real wealth outlined here also provides one hypothesis which has been advanced to explain the puzzling change observed in post-rehousing absences.

(3) The environment external to housing must remain unchanged over the measurement period or its effects must be capable of being held constant.

As noted above, Zacapu acquired a sanitary produce market in 1965. A whole array of other factors constantly operated upon individual health and productivity. Their effects, however, were not limited to the rehoused workers. There is no reason to suppose, in fact, that the rehoused workers were affected differently than would be a random sample of Celanese workers. At this point it is necessary to define a "test" group and a "control" group. Although 76 houses were built, not all were still occupied by Celanese workers when an on-site census of housing was conducted the week of July 10-17, 1967. At least nine were rented out by their owners and one was unoccupied. Two or more

attempts were made to contact the residents of each house. The ten houses rented or unoccupied were ignored.[3] From the remaining 66 houses, 50 housing questionnaires were obtained (see Appendix I). There is no reason to believe that a non-random sample was taken.

Each of these 50 persons had lived in the project since its construction. Each had also been continuously in the employ of Celanese Mexicana over the entire test period. The 50 persons for whom questionnaires were completed comprise the "test" or "rehoused" group. Ten Loma Jardin residents work under a form of incentive system. These are used in the productivity section of the study. The 50 member group is used in the analysis of absenteeism.

A randomly selected group of 50 Celanese workers was used as a "control" group. Unfortunately, it was impossible to determine whether or not they experienced a change in housing quality during the test period. Since Loma Jardin is the major new housing development in Zacapu, it is assumed that they did not. Of the 50, 35 were matched department by department with Loma Jardin residents. The other 15 were matched by white collar vs. blue collar. This matching was done to eliminate as far as possible changes in health or productivity due to changes in the plant environment. Absenteeism data were obtained for all 50 and productivity data for a matched group of 10. It must be emphasized that selection of the control group was made "randomly" from

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[3] The high proportion rented out may indicate an attempt by the owners to convert their capital gain into current income.

company files, subject to the matching of departments.[4] The control group eliminates the influence of changes in the general environment and makes possible the following "controlled experiment":

	Before Rehousing			After Rehousing	
	1964	1965	Rehousing Jan. 1, 1966	1966	1967
Test Group	50 workers in housing of varying quality			The same 50 workers rehoused in Lona Jardin	
Control Group	50 workers not rehoused			The same 50 workers not rehoused	

(4) The worker must be able to control his level and rate of production.

The production process in the Celanese plant is highly automated. It consists essentially in the conversion of large sheets of dried wood pulp into a viscous liquid; the extrusion of this liquid through very fine nozzles, causing it to solidify into thread; and the washing, dyeing, and spinning of the thread. Nearly all of the actual production process is based upon automatic machinery, which runs 24 hours daily. The large number of human workers is required to maintain the machines, to fabricate spare parts in the machine shop, and to supervise both the delicate spinning machines and the large number of processes requiring corrosive chemicals. Although maximum output is machine dictated, actual production is a function of the number of daily hours the machine is run. This in turn depends on the quality of maintenance and of machine tending.

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[4]Control group names were drawn from worker lists by a company employee who did not know the purpose of the study and who was asked to make the drawing "at random" subject to the criteria of department and length of service.

About 40 percent of the Loma Jardin residents have no direct role in the production process. Among them are laboratory technicians, engineers, clerks, and security guards. Although these workers are capable of increasing their personal efficiency, improvements will not necessarily be reflected in increased output of product, but more probably in lower total costs. The remaining 60 percent exercise a more direct influence on physical production. It is postulated that improvements in motivation and in physical health due to a better home environment will be reflected in more attentive care of machinery and hence in greater departmental output.

(5) Changes in labor productivity must be measurable in quantitative units of output.

Only 10 of the rehoused workers are paid under the incentive system, our measure of labor productivity. Thus possible changes in productivity can be measured for only a small fraction of the workers rehoused. Each of the 10 was matched with a non-rehoused worker in the same department. These workers are paid a flat wage of 35-65 pesos per day plus a bonus which depends on the output of their work group and averages one-fifth of total compensation. These work groups range from 1 to 35 members. The problem here is that the bonus is not paid on the basis of individual productivity but on the basis of a group which may include both rehoused and non-rehoused workers. A rehoused individual's improvement in productivity must be quite high to improve the record of his entire group. Since departments are composed of a number of work groups, each performing the same task, the matching of test and control

workers by departments does not necessarily imply that they are in the same work group, although it does not preclude the possibility.

Site Selection and Data Collection

The Zacapu test site was selected while Loma Jardin was still under construction. The Project Director, with the cooperation of the Agency for International Development and the U.S. Embassy, Mexico City, visited Zacapu in August 1965. By early 1967 it was considered that the project had been occupied for a time long enough to warrant data collection. A staff member visited Zacapu in February 1967. At this time it was discovered that only 10 rehoused workers were paid incentive wages. A control group of 10 was selected from matched departments and 1965 and 1966 bonuses compared for test and control groups.

The author first visited Zacapu in July 1967. A questionnaire was administered to 50 Loma Jardin residents, all of whom had lived in the colony since its inception and were currently employed by Celanese Mexicana. The questions were given orally in Spanish. Not a single resident contacted failed to cooperate fully with the survey. Although the questionnaire had been briefly pre-tested among recent Mexican immigrants in Riverside, California, unforeseen conditions in Zacapu caused the questions on commuting time before and after rehousing to be dropped. They were eliminated when it was discovered that bus service provided by the union made the change negligible. A detailed analysis of responses is presented in Appendix I.

Data on absenteeism for the 50 member test and control groups were collected from company employment records for the pre-rehousing year 1965 and the initial post-rehousing year 1966. After analysis of this

information, it was deemed advisable to extend the secular scope of the investigation to include an additional pre-rehousing year (1964) and an additional post-rehousing year (1967). Problems arose with the use of absenteeism as a measure of health change and it became necessary to seek more direct health measures.

The author returned to Zacapu in January 1968 to collect this additional information. Celanese Mexicana again cooperated by providing bonus and absenteeism data for 1964 and 1967. The Instituto Mexicano del Seguro Social (the Mexican social insurance authority) allowed the author access to individual medical records for test and control group workers for the 1964 through 1967 period. A capable local doctor assisted in translating individual diagnoses into a standardized international medical classification.

IV. THE HOUSING AND PRODUCTIVITY RELATIONSHIP

This section tests the hypothesis that an improvement in housing, working through better motivation and physical health, can cause an increase in labor productivity. Productivity is measured by the change in test versus control group bonus payments before and after rehousing for groups of 10 workers engaged in machine tending and maintenance. The bonus, based on work group output, is the closest available approximation to individual productivity. Production is machine paced and output may be increased only by decreasing down-time through more attentive maintenance and more careful machine operation. There has been little technical change in the rayon making process and new capital investment in the plant is negligible.

Bonus data for test and control groups (n=10) were obtained for each of the two years before and two years after rehousing. Since bonuses are paid only for days actually worked, the productivity measure used is bonus per day worked. The effects of housing on absenteeism will be discussed in Section V.

The following table, drawn from Table 1 below, presents average bonuses per day for each group:

	Before Rehousing		After Rehousing	
	1964	1965	1966	1967
Test	11.16 pesos/day	14.87	17.20	21.99
Control	12.59	18.46	17.71	23.58

TABLE 1

PRODUCTIVITY BONUSES

Test Group

Worker Number	Department	1965 Bonus Per Day	1966 Bonus Per Day	Percentage Δ Bonus Per Day 1966 - 1965
1	Extrusion	5.35 pesos	6.02	12.52
2	Purification	15.35	17.41	13.42
3	Purification	11.31	14.21	25.64
4	Packing	11.08	14.51	30.96
5	Packing	12.90	15.54	20.46
6	Packing	13.60	18.25	34.19
7	Packing	9.75	11.79	20.92
8	Coagulation	21.96	24.89	13.34
9	Coagulation	22.53	20.51	-8.96
10	Coagulation	24.88	28.90	16.16

Control Group

Worker Number	Department	1965 Bonus Per Day	1966 Bonus Per Day	Percentage Δ Bonus Per Day 1966 - 1965
11	Extrusion	5.76	5.76	0.00
12	Purification	17.33	14.73	-15.00
13	Purification	14.03	14.51	3.42
14	Packing	16.10	17.06	5.96
15	Packing	17.00	16.76	-1.41
16	Packing	21.64	22.01	1.71
17	Packing	16.16	14.18	-12.25
18	Coagulation	34.52	28.30	-18.02
19	Coagulation	22.27	22.12	-0.67
20	Coagulation	19.76	21.69	9.77

During the two years before rehousing, bonuses per day worked of control group members significantly exceeded those of their test group counterparts. For the two post-rehousing years, however, test and control group bonus/day did not differ significantly.[1] This is at least indirect evidence of a positive change in productivity for rehoused workers over and above that of the control group.

A more powerful test, which shows more clearly the annual change in bonus/day involves regression of the change in bonus/day between a base pre-rehousing year (1965) and successive post-rehousing years against a dummy variable identifying individuals as belonging to the test or control group (H=1 for rehoused workers). This test reveals that in the first year after rehousing, the test group achieved an increase in bonus which differed significantly from that of the control group. The increased bonus, however, was a short-lived phenomenon and there was no statistically significant difference in the change over the entire two year period between the groups.

(1) Δ bonus per day (1966-1965) = -0.745 + 3.08H $\quad R^2 = .369$
(.948)

(2) Δ bonus per day (1967-1965) = 5.119 + 2.00H $\quad R^2 = .147$
(1.13)

(Standard error in parentheses, n=20)

The coefficient of H in (1) is significant at the .01 level. There is only one chance in a hundred that the observed difference between the

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[1] Mean Difference (Test - Control) (for individuals paired by dept.)

1964	1965	1966	1967
-1.44**	-3.59*	-0.51	-1.59
(.454)	(1.54)	(1.05)	(1.29)

** significant at .01 level
* significant at .05 level

(Standard error in parentheses, n=10)

groups arose from sampling error, i.e., that the test group increase in bonus did not actually exceed the control group's change.

It was hypothesized that the response of a worker to improved housing would vary with his level of skill. Workers with a high level of skill would be expected to exhibit a greater absolute increase in productivity than would workers of lesser initial attainment who experienced the same housing improvement. To cite an extreme case, an increase in productivity of $100 yearly would amount to 10% for a worker earning $1000 yearly but only 1% for a worker initially earning $10,000. This hypothesis was not borne out by the evidence. Inclusion of the level of 1965 bonus (B1965) improved the fit of the regression line but the variable did not enter with the expected sign nor was its coefficient significantly different from zero at the .05 level.[2] Workers' response to the stimulus of rehousing was evidently not determined by their previous level of skill or motivation.

The regressions indicate that the rehoused workers experienced a sudden but seemingly temporary increase in measured productivity. As a check on the reliability of regression (1), an alternative method was used. During the first year after rehousing, nine test group workers increased their bonus/day while one failed to do so. Similarly, four control group workers achieved a higher bonus and six did not. The probability that this pattern was due merely to chance is .029.[3]

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[2] Δ bonus per day (1966-1965) = 1.415 + 2.657H (.938) - 0.117 [B1965] (.070) R^2=.458

[3] See Appendix IV for calculations.

Following regression (1) we can attribute a temporary increase in bonus of 3.08 pesos per day directly to rehousing. This figure is equal to the difference between the actual test group increase of 2.33 pesos and the control group decrease of 0.75 pesos. The regression method assumes that, in the absence of rehousing, test group productivity would change in the same direction and amount as control group productivity.

Test group members worked an average of 20.3 days per month in 1966. The monthly increase in bonus due to rehousing was thus 3.08 x (20.3) = 62.52 pesos per month. This gain represents only that portion of the productivity gain accruing to the workers themselves. Unless Celanese returns the entire amount of productivity increases to its workers, the total gain due to housing will be understated. The bonus is calculated by applying the ratio of available machine time to standard machine time to the base wage. Thus, if available machine time exceeds the standard by 20% a bonus of 20% of the base wage is paid.

No direct information is available regarding the company share in productivity gains. Some inferences may be drawn, however, from the 1961 Mexican Industrial Census.[4] The cost data presented cover four plants in the synthetic fiber industry in the states of Jalisco, Mexico, Michoacan, and the Federal District. Probably the largest of these is the Celanese plant in Zacapu, Michoacan. In 1960 the four plants together employed 2,959 persons, a little more than twice the number

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[4] Mexico. Direccion General de Estadistica. VII Censo Industrial, Resumen General. (1965) pp. 65 and 185. "Fabricacion de Fibras Sinteticas," SIC classification 3112.

the Zacapu plant employed in 1965. The cost breakdown is as follows:

Costs as a Percentage of Value of Output

Materials and packaging	52.48%
Wages and Salaries	13.31
Social Charges	.79
Fuels and Lubricants	3.41
Electricity (at .165 peso/KWH)	3.56
Other costs	3.46
Fixed Costs (residual)	22.99
	100.00

"Fixed costs," which include profits and interest charges among other factors, are equal to wage costs multiplied by a factor of 1.73. This relation can be used to estimate the company share in additional product output due to rehousing. The Celanese method of calculating the bonus makes the labor share in marginal gross product equal to the labor share in total gross product. Thus if productivity, i.e., machine time, rises 20%, and labor payments rise 20%, the return to fixed factors will increase by the same percentage.[5] If fixed factors are paid 1.73 times the labor share in total product, they will obtain the same multiple of the productivity bonus. All of this increase is attributed to profits, that is, we assume that more intensive use of fixed factors costs nothing. This is not an unreasonable assumption with regard to buildings and to auxiliary machinery, such as the water

[5]It is assumed here that payments to other variable factors besides labor also increase proportionately, i.e., 20% more raw materials are needed.

supply system. Although it is possible that more intensive use of production line machinery will cause it to depreciate more rapidly, the machinery was designed for 24 hour operation. If it is shut down frequently for repairs, the very process of resuming production may be more harmful than would continuous use.

Part of the labor input (security guards and administration, for example) is fixed as well. It is highly probable that this will be large enough to offset rises in user cost associated with the more intensive use of production line equipment. Thus the method of estimation is a quite conservative one.

The company share in the additional productivity will be (62.5) x (1.73) = 108.2 pesos per month. This quantity will be a component of the return to the company on its investment in the housing subsidy.[6] The return during the second year after rehousing is estimated to be zero. Further discussion of the return as well as some possible explanations of its origin and its temporary nature will be deferred to Section V (pp. 43-45) below. --

The next section will explore the behavior of health before and after rehousing.

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[6]Obviously, changes in number of days worked will also affect the profitability of rehousing. These will be discussed in Section V.

V. THE HOUSING AND HEALTH RELATIONSHIP

Our working hypothesis has been that increases in productivity subsequent to rehousing come about at least partially as a direct result of a higher level of physical health. This section is devoted to examining the impact of housing on two crude measures of physical health, illness related absenteeism and visits to a medical facility, and to evaluating the usefulness of absenteeism as a measure of health.

Rehousing and Absenteeism

The immediate impact of rehousing on illness related absenteeism, our initial measure of health change, was the exact opposite of that anticipated. During the first post-rehousing year, absences due to (reported) illness rose 105.1 percent among the test group while falling by 36.5 percent for the control group.[1] No divergent trend in absences between test and control groups was observed prior to rehousing. After the sharp rise of the initial year, test group absences fell somewhat but did not immediately reach their pre-rehousing level. The following regressions, relating the changes in absences between pairs of succeeding years for test and control groups, illustrate these observations. As in the preceding section, the dummy variable H

[1] Here the full 50 member test and control groups are used, giving the regressions 98 degrees of freedom. A summary of the absence data may be found in Table 2.

TABLE 2

MEAN YEARLY ABSENCES PER PERSON ATTRIBUTED TO ILLNESS

(in days)

	1964	1965	1966	1967
Test Group	5.04	4.84	9.92	7.69
Control Group	9.88	8.84	5.61	11.08

n = 50 test

n = 50 control

identifies a worker as being a member of the test or control group [H=1 for rehoused workers].

(1)Pre-rehousing Δ absences (1965-1964) = -1.04 + 0.84 H (3.75) R^2 = .0005

(2)Rehousing Δ absences (1966-1965) = -3.22 + 8.31 H (3.94) R^2 = .044

(3)Post-rehousing Δ absences (1967-1966) = 5.47 - 7.69 H (4.18) R^2 = .034

The coefficient of H in (2) is significant at the .05 level. The significance of this puzzling increase in absences is, however, not unambiguous. A chi-square test, which grouped test and control group members according to whether they had improved or failed to improve their absence record between 1965 and 1966, did not reveal a significant difference between the groups at even the .30 level.[2] These tests suggest that rehousing had little discernable effect on the absences of most test group workers, but that those experiencing increases in absences tended to show increases of relatively large magnitude. Some hypotheses which might explain the unexpected rise in absenteeism during the first post-rehousing year will be tested later in this section.

For the purpose of estimating the return to investment in housing, we will attribute [from Equation (2)] a first year increase in absences of 8.31 days per worker to rehousing. Any cost to the company which this involved must be subtracted from the previously noted productivity gain. Since the company does not pay sick pay, this cost is

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[2]See Appendix IV for computations.

taken as the loss in potential profits due to the absence of individual workers. This cost does not seem to be amenable to direct measurement. The increase in absences, like the increase in productivity, did not extend into the second post-rehousing year. Regression of the change in absences between 1967 and 1965 against the rehousing dummy shows no significant difference in amount of change between test and control groups.

Rehousing and the Demand for Medical Care

In order to obtain a more direct measure of worker health, medical records were secured for test and control group members from the local hospital-clinic of the Mexican Social Security Institute. A more complete rendering of the health care system in Zacapu is presented in Appendix II. It is sufficient to note here that medical care of seemingly high quality is available free of charge to test and control group workers and their families. The clinic is located on the road to the factory, making access equally convenient for members of both groups. Complete medical records, covering outpatient and inpatient (hospital) care,[3] were obtained for 46 test and 46 control group workers for the two years before and two years after rehousing.

A summary of inpatient days and outpatient visits is presented in Table 3. During the two years after rehousing, test group workers required 18 more outpatient visits than they had in the previous two years [an average increase of .20 visits per worker per year]. Control

[3]Inpatient days are understated for both groups since patients requiring major surgery and certain laboratory tests are referred to the Social Security hospital in Morelia.

TABLE 3

OUTPATIENT VISITS AND INPATIENT DAYS AT SOCIAL SECURITY CLINIC

	1964	1965	1966	1967
Total Outpatient Visits				
Test	242	246	233	273
Control	275	249	237	303
Mean Outpatient Visits				
Test	5.26	5.35	5.06	5.93
Control	5.98	5.41	5.15	6.59
Total Hospital Days				
Test	2(1)	0	18(4)	13(2)
Control	56(2)	9(2)	17(3)	11(2)

Figures in parentheses refer to number of patients involved

n = 46 test
n = 46 control

group members required a total of 16 more visits. Chi-square tests showed no significant difference between test and control group changes for either inpatient or outpatient care.[4]

The increase in absences observed among the test group in 1966 was thus not accompanied by a significant increase in the demand for medical services, even when these services were available at a zero money cost. This evidence indicates that absenteeism is a complex phenomenon, and one determined only in part by the incidence of visits to a medical facility (a crude measure of the extent of actual illness). Lack of data, however, may make it necessary to use absenteeism as a measure of health change in future housing/health studies. We are here in a unique position to assess the reliability of absenteeism as a health measure.

Absenteeism as a Measure of Health

The use of changes in absenteeism as a measure of actual health change depends on the assumption that there is some stable monotonic relationship between the two. If there is either no relation or if the functional relationship is changed by the rehousing process itself, absenteeism will be a biased estimator. We have attempted to delineate the relationship involved by assuming that the number of absences per clinic visit is constant and determining whether plausible hypotheses can be formed to explain deviations from the expected behavior.

It is first necessary, however, to define the scope of this report's treatment of absences. Among Celanese Mexicana workers,

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[4]See Appendix IV for calculations.

absences are frequently found for reasons other than illness - and classified by the company as unjustified, industrial accident, and permit. If rehousing changes employee preferences among these types of absences, the use of illness absences alone as an indicator of worker behavior will over or understate the net changes in absences which are taking place. Because this report is concerned with absences as a measure of health, only those absences attributed to illness or non-work accidents are used.[5] A complete analysis of the impact of rehousing on the labor supply function would include all categories of absences. Because of this fact, our conclusions regarding the housing/labor supply mechanism must be regarded somewhat more cautiously than those regarding the housing/health mechanism. It must be emphasized that the present report is not an attempt to formulate a complete theory of industrial absenteeism but to illuminate some of the problems involved in using absenteeism as a health measure.

Over the four years covered by this study, the 92 workers for whom both health and absence data were collected paid a total of 2,058 visits to the clinic. During the same period they accounted for 2,855 absences attributed to illness, or an average of 1.39 days absent per clinic visit. Using this figure as our constant of proportionality, we can estimate an expected number of yearly absences for each group

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[5]Industrial accidents were eliminated from the absence data because of the predominance of extreme cases and because it was feared that they would unduly complicate our analysis of the health mechanisms presented in Section VI. Unfortunately, it was impossible to separate accidents by place of occurrence in the statistics on outpatient visits. Table A-1 in Appendix II shows, however, that the behavior of total accidents over the period did not differ between the test and control groups.

from its number of visits. The results are presented in Table 4 below.

The absence/illness ratio was far from constant, even before rehousing, although there was a marked difference in its value between the two groups. Between 1964 and 1965, test group absences rose 14.6% while clinic visits rose only 1.6%. For the control group, absences fell 1.7% but visits fell 9.5%.[6] It is immediately apparent from Column 4, however, that during the first year after rehousing both groups departed particularly sharply from their previous behavior patterns. Actual absences exceeded expected absences for the test group, while the opposite was true for the control group.

By 1967 the control group had returned to its "normal" absence/illness relationship while the test group was tending in that direction. The major failure of absences as a measure of changes in health thus occurred during the first year after rehousing. We will begin by testing some hypotheses about the test group's behavior during this initial year.

Hypothesis I - That the flood which occurred in the summer of 1966 in some way caused the higher level of absences observed in that year. Since only about 40 percent of Loma Jardin was flooded, we may separate the test group into sub-groups according to whether or not

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[6]It is interesting to note that while per capita clinic visits for test and control groups were almost identical, the control group registered almost twice as many per capita absences. We may speculate that test group members, being particularly dissatisfied with their housing, desired to stay home fewer days for any given level of illness. This type of behavior is consistent with an hypothesis presented below (Hypothesis IV, pp. 41, 42) which explains at least partially the change in the absence/visit ratio which occurred among the test group after rehousing.

TABLE 4

ACTUAL VERSUS EXPECTED ABSENCES (1964-1967)

	(1) Visits to Clinic	(2) Actual Illness Absences	(3) Expected Absences	(4) Actual-Expected
Test Group				
1964	242	205	336	-131
1965	246	235	342	-107
1966	233	421	324	+97
1967	273	342	379	-37
Control Group				
1964	275	430	382	+48
1965	249	423	346	+77
1966	237	269	329	-60
1967	303	530	421	+109

Expected illness absences estimated at 1.39 per clinic visit.

n = 46 test
n = 46 control

they lived in the flooded area. Two flooding variables were proposed, HFLOD, attached to those persons whose homes were in the most heavily flooded area, and LFLOD, given to those with minor flooding problems. When 1966 absences were regressed on these flood variables, neither was found to be significant at the .05 level. The hypothesis was rejected.

Hypothesis II - During the early stages of this study, when data had been collected for only a single year before and a single year after rehousing, it was suggested that the increase in test group absences in 1966 over 1965 was due merely to an abnormally low absence rate for test group workers in 1965. Test group absences ran only 55.6 percent of control group absences in that year. Although the workers did not move into the project until November 1965, they were aware of the impending move over most of the year. They also knew that the payments on the new house would exceed their current rent by an average of 137 pesos. Rises in other living costs were also anticipated. Many of the new homes, for instance, have new furniture and appliances.

It was postulated that test group workers were absent less than usual in 1965 in an effort to anticipate these extra costs. Sick pay benefits, paid by the labor union and by social insurance, amount to 60-75 percent of the base wage, making absences a real financial cost to the worker. When additional data were secured, however, test group absences for 1964 were found to be almost identical to those for 1965. Thus absences during the base year were not below their normal level. Hypothesis II was rejected.

Hypothesis III - That the increase in wealth due to the housing subsidy and the income effect of the added bonus obtained by incentive

workers caused the consumption of leisure (in the form of feigned illness) to rise among rehoused workers.

If, as appears true empirically, leisure is a superior good and if consumption is a function of wealth or permanent income, the demand for leisure time will rise as real wealth rises. As had been noted above, residents of Loma Jardin obtained a capital gain on their property equal to about 8 1/2 months wages. This "wealth effect" is somewhat complicated for the 10 test group workers paid under the productivity bonus system. Their higher bonus raised the return to working additional days, since the bonus is paid only for those days actually worked.[7] While the wealth effect predicts that absenteeism would rise, this "price effect" or "substitution effect" indicates that it would fall. The relative impact of these effects on the supply of labor can be determined only if the individual workers' labor/leisure indifference curves are known. We may, however, estimate the relative magnitude of the price change relative to the wealth change. The analysis is illustrated graphically in Figure 2.

Before rehousing the 10 test group incentive workers could work a maximum of 23.9 days monthly (6.5 days weekly) at a total wage of 1904 pesos. Rehousing had three effects --

(a) The subsidy of 2632 pesos per worker plus the capital gain of about 10 000 pesos due to rising housing values and the 4260 peso interest subsidy yielded an imputed addition to permanent income (at 9 percent per annum) of about 125 pesos per month.

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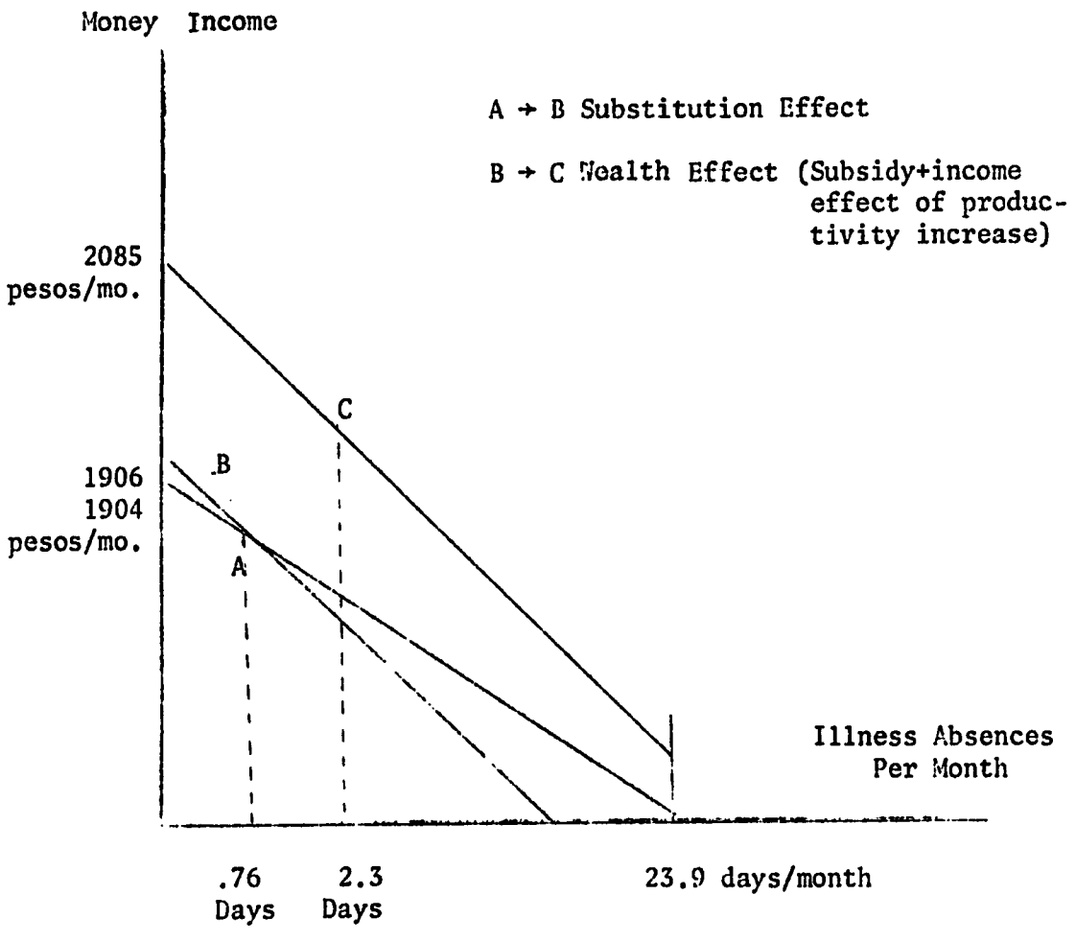
[7] The increase in bonus per day is assumed here to be independent of changes in absenteeism. This assumption is discarded in Hypothesis V below.

FIGURE 2

GRAPHICAL ILLUSTRATION OF HYPOTHESIS III



(b) For those paid incentive bonuses, the income effect of increased productivity raised maximum possible income another 56 pesos monthly (54 pesos at point A).

(c) The increase in bonus raised the slope of the wage line by 2.33 pesos per day.

The exact magnitude of the substitution effect cannot be determined without knowing the indifference maps of the workers. It is likely, however, that the wealth effect exceeded the substitution effect. This is indicated by the fact that (at point A) the workers' income rose by 11.0 percent, while the daily wage rose only 2.9 percent. It must be noted, however, that even if the substitution effect were exactly measurable, the movement from point A to point C cannot be attributed to wage changes alone. The very purpose of the study is to explore the effects of housing on health, a phenomenon which changes the shape of the money/leisure indifference map by changing the utility of leisure.

The "wealth effect" is an appealingly neat way of accounting for the post-rehousing increase in test group absences. Unfortunately, it is at variance with two important pieces of empirical evidence. First, the rise in real wealth was a permanent one, while the increase in absences was only temporary. Given, in fact, the continuing rise in property values in Loma Jardin, we would expect a steadily rising level of absences which would parallel the steady rise in wealth.

A second test is provided by division of the test group into three sub-groups -- blue collar incentive workers, blue collar non-incentive workers, and white collar workers. Each of these, theoretically, should be affected differently by a wealth effect. Blue collar

non-incentive workers experience a rise in wealth but no substitution effect. White collar workers experience a rise in wealth somewhat smaller relative to their income than do the former. (White collar test group workers earn about 40 percent more than do test group production workers.) Blue collar incentive workers experience both a wealth effect and an offsetting substitution effect. Assuming that all groups have the same income elasticity of demand for leisure, the theory predicts that if the wealth effect is a significant determinant of the change in absences, absences will increase most among blue collar non-incentive workers, somewhat less among white collar workers, and least among blue collar incentive workers. The following breakdown does not bear out this ordering.[8]

Mean Illness Absences Per Year

	1965	1966
Blue collar incentive	9.1	27.7
Blue collar non-incentive	3.8	6.2
White collar	6.3	6.4

The "wealth effect" thus does not provide an explanation which consistently predicts behavior in the Zacapu case.

Hypothesis IV - That the improved quality of the home environment relative to the work environment caused workers to increase the time spent at home for a given level of illness. This implies that the

[8]Because of the small number in each category, extreme cases would be expected to diminish the reliability of means. The conclusions are not markedly different when median rather than mean absences are used for each group.

ratio of absences to clinic visits rose among test group workers after rehousing. This hypothesis is given support by the results of a regression relating the change in absences between 1965 and 1966 to a number of variables representing housing quality change.[9] Increases in absences were associated with improvements in measures of crowding and occupancy intensity. These perhaps measure the attractiveness of the home as a place in which to recuperate from illness.

As with Hypothesis III, however, this explanation does not account for the behavior of absences in both post-rehousing years. The ratio of absences per visit among the test group, which was .90 before rehousing, rose to 1.81 in the first post-rehousing year. The following year, however, the ratio fell to 1.25. Hypothesis IV, while certainly not disproved by the data, cannot account for more than about 40 percent of the post-rehousing change in absences.

Hypothesis V - That the fact of moving into a new home caused marginal productivity in household activities to rise relative to the wage in factory employment. As noted in the introduction, Loma Jardin residents have devoted themselves enthusiastically to improving their new homes, particularly to landscaping and the construction of walls and enclosed patios. Hypothesis V leads us to expect this activity to hit a peak during the initial post-rehousing year, when the range of possible improvements was greatest. As these are made, the marginal utility of continued improvements should fall. We would expect

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[9] The quality measures are defined and discussed in Section VI below. Reductions in families per house (FAMS) and persons per room (CHPRM) were significantly (.01 level) associated with increases in absences.

absences to fall slowly back toward their original level in subsequent post-rehousing years. This hypothesis is consistent with the observed behavior of absences in both years after rehousing.

Hypothesis V also provides an explanation for the significant but temporary rise in productivity in the factory among those test group workers who were paid under the incentive system. The mechanism postulated is as follows -- all new residents of Loma Jardin experienced a rise in "household sector" productivity. In an attempt to equalize marginal products in the market and household sectors, residents increased their incidence of feigned illness, causing the ratio of absences to illnesses (clinic visits) to rise sharply. The test group as a whole was somewhat limited in its ability to make such a substitution, since the payments on the new houses (352 pesos monthly) exceeded the average rent in their previous homes (214 pesos). The new obligation would be expected to raise the marginal utility of money income for test group workers, since workers who fail to meet their payments risk losing their new house. Incentive workers were able to avoid this limitation, however, by working harder on those days on which they worked in the factory. The higher bonuses they achieved enabled them to increase the number of days spent working in the home.

Hypothesis V predicts that incentive system workers will, at a given level of household sector productivity, supply more labor to the household sector than will non-incentive workers. This is confirmed by the observation on p. 41 above that incentive workers increased their absences by more days than did either category of non-incentive

workers.[10] By working harder, incentive workers were able to hold money income almost constant, despite a mean increase in absenteeism of 18.6 days per worker per year. The income lost through absenteeism, net of benefits received from the labor union and from the Social Security Institute, can be roughly estimated at between 910 and 1000 pesos per worker for the first post-rehousing year. The added income afforded by the increased productivity bonus amounted to 744 pesos per worker per year.

An alternative mechanism relating increased productivity to higher absenteeism does not require the assumption that workers sought to maintain a target level of money income. It postulates that, faced with higher marginal productivity in the household sector, incentive system workers simultaneously adjusted their work effort in both factory and household sectors so as to equalize marginal products in each. As additional absences were taken during the first post-rehousing year, marginal product in the household sector fell. At the same time the increased work effort made in the factory sector caused marginal productivity there to rise. Adjustment stopped at that number of absences which equalized marginal product in both factory and household. When

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[10] The hypothesis is given additional, although indirect, support by a study of 125 workers in an automated automobile engine plant in the U.S., which indicated that workers are quite aware of their productivity in household tasks. When asked what they would like to do if they had either a shorter work week or longer vacations, 96.8 percent listed "work around the house", a higher figure than for any other response. William A. Faunce, "Automation and Leisure" in Edwin O. Smigel, ed., Work and Leisure, (New Haven: 1963) p. 92.

exhaustion of the stock of possible home improvements during the second post-rehousing year caused marginal product in the household sector to fall, workers took fewer absences and expended somewhat less effort at work. Again, marginal products were equalized in both sectors, but at a lower level of absenteeism and a smaller change in productivity bonus. Both this mechanism and that involving the "target income" assumption are fully consistent with the general assertion of Hypothesis V that the temporary rise in productivity on the job was a result of the temporary rise in productivity in the household sector.

A direct test of Hypothesis V was attempted, using interview data obtained from 26 test group members two years after rehousing. Workers were asked if they had undertaken major home improvements since moving into Loma Jardin. Fourteen of the 26 (54 percent) answered affirmatively, most of them mentioning the construction of fences or patios. The construction of home improvements, measured by a dummy variable, was associated positively ($r = .116$), although not significantly,[11] with increases in absences during the initial post-rehousing year. When health changes (Δ clinic visits) were held constant, however, the partial correlation of home improvements with changes in absences was neglibible ($r_b = .020$). Some doubt must be attached to this result because of the suspected non-random character of the sample of 26. The mean increase in absences for these workers during the initial post-rehousing year was only .04 days per year against a mean increase of 5.08 days per year for the test group as a whole. The test also

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[11]Not significant at the .05 level.

fails to consider landscaping and minor home improvements, which may have been of particular importance during the first year after re-housing.

Hypothesis V can be neither confirmed nor disproved with the data available. It remains the most intuitively appealing and most logically consistent of the hypotheses considered. Nevertheless, we cannot deny a possible role for Hypothesis IV, nor can we ignore the possibility that workers feigned illness during the initial year merely to enjoy the amenities provided by their new home. Neither of these latter explanations, furthermore, contradicts our theory of the housing/productivity mechanism (target income variant).

It has become apparent that the return to firms from investment in worker housing depends not only on changes in the physical health of workers but on the often complex forces underlying the labor supply curve. Because of these forces, the Zacapu experience indicates that absences attributed to illness are not a reliable measure of health or of health change and cannot be safely used as a proxy for more direct health measures.

VI. HOUSING AND HEALTH: ISOLATING A CAUSAL RELATIONSHIP

The observation that housing was not positively related to health for the test group as a whole does not necessarily imply that housing and health were unrelated for every test group member. It has been observed that 82 percent of the rehoused workers moved not because of bad conditions in their former home but because of the opportunity they were given for home ownership. We would thus expect rehoused workers to have experienced a wide variety of changes in physical housing quality. The housing inventory taken as part of this study revealed that some individuals experienced very small improvements or even no improvement in housing quality. Others, even though they moved primarily to obtain the psychological satisfaction of home ownership, found the physical quality of the new housing substantially higher than that of the old.

On average, however, a large improvement in physical housing quality was experienced. Before rehousing, 32 percent of test group families lacked hot water, 42 percent had a kitchen which was not connected with the other rooms, 24 percent had no private bath. All these amenities are provided in Loma Jardin. Thirty families (60 percent) had complained of rats, only one did in Loma Jardin. The mean number of persons per room fell from 1.70 to 1.28 or about 25 percent. Subjectively, as well as objectively, Loma Jardin residents had improved their housing. When asked what house they preferred of all those in

which they had lived since their marriage, 82 percent favored their present house, while only four percent preferred the house in which they had lived during our "pre-rehousing" period.

The data obtained from the housing questionnaire, it is postulated, will enable comparison of the magnitude of the change in physical housing quality with the magnitude of the change in absences for each individual. This enables us to test the corollary of the housing/health hypothesis that "the magnitude of the improvement in health will be a positive function of the magnitude of the housing improvement." The housing census data have been coded into 14 quality change variables, ranging from the change in rat infestation and sanitary services to changes in persons per room. These must be weighted in some way if we wish to obtain a single index of housing quality change. The variables are summarized in Figure 3. Simple correlations between them are presented in Appendix V.

Housing Quality Change and Absenteeism

As a first approximation to the quality change which was experienced, 13 of the quality change variables[1] were weighted equally. Rehoused workers were assigned a number corresponding to the total number of improvements which they experienced. The mean improvement score of test group members was 4.5, with a range from 0 to 11. The change in absences (1966/67 - 1964/65) experienced by each test group member was regressed against his

[1] COSPR is omitted because there are conflicting a priori notions about the relation between housing costs and health.

FIGURE 5

HOUSING QUALITY VARIABLES

Name of Variable	Definition of Variable
INSEC	Insect problem in former house and no insect problem in present house.
RATS	Rats in former house and no rats in present house.
ANIML	Animals (other than dogs and cats) before and no animals after. Includes animals kept by nearby neighbors if these were complained of.
USCRD	A measure of "use-crowding", the use of a single room for both sleeping and other purposes. In this case the variable refers to use-crowding before and no use-crowding after.
FAMS	More than one family before and a single family in present house. Family is defined as the nuclear family plus the parents of either spouse.
GARBG	Less than daily frequency of garbage collection at former house.
TOILT	Outside toilet or lack of toilet at former house.
HWAT	Lack of piped hot water at former house.
BATH	Lack of private bath at former house.
CHPRM	Persons/room in former house minus persons/room in present house, i.e., Δ persons per room.
QLCHG	A subjective variable based on the free response questions 12, 13, 28 and 29. Positive QLCHG indicates that the respondent had many complaints about the former house and few about the present one. The substance of statements was given less importance than the vehemence with which they were made.

KITCH	Kitchen in former house not directly connected with other rooms. This is a characteristic of "traditional" Mexican houses about which many test group members complained.
WINDW	Lack of windows in kitchen or bedrooms in former house.
COSPR	Cost/person in present house minus cost/person in former house, i.e., Δ expenditure per person.

If the hypothesis holds that housing improvement leads to better health and if the magnitude of the housing improvement determines the magnitude of the health change, we would expect regression of Δ absences on the above variables to yeild negative signs on all variables but COSPR. The expected sign of COSPR is discussed on p. 54 below.

improvement score (variable name IMPRV). Theory leads us to expect that Δ absences would be negatively correlated with the improvement score. The regression failed to support this hypothesis:

$$\Delta \text{ absences } (1966/67 - 1964/65) = -0.71 + \underset{(1.68)}{3.15}\ \text{IMPRV} \qquad R^2 = .074$$

The coefficient of IMPRV is significant at the .10 level but not at the .05 level.[2] Thus persons experiencing the greatest improvement in housing tended to exhibit the greatest increases in absenteeism. This result is not consistent with our original housing/health hypothesis but fits in well with Hypotheses IV and V above. It appears reasonable that those workers who experienced the greatest rise in housing quality felt the greatest desire to enjoy the services of their new home and to make further improvements to it.

Housing Quality Change and Outpatient Visits

As we have observed earlier, absenteeism is an imperfect measure of physical health. A more appropriate test of the housing/health relationship - as distinct from the housing/behavior relationship - is outpatient visits to the Social Security clinic.

The change in outpatient visits (1966/67 - 1964/65) was regressed on the housing quality variable. The coefficient of IMPRV was not significantly different from zero.

$$\Delta \text{ outpatient visits} = 4.09 + \underset{(0.36)}{0.37}\ \text{IMPRV} \qquad R^2 = .024$$

[2]The relationship between the change in absences and the improvement score becomes somewhat less pronounced when the change in clinic visits is held constant, but the sign of IMPRV remains positive.

$$\Delta \text{ absences} = -12.22 + \underset{(0.57)}{2.81}\ \Delta \text{ visits} + \underset{(1.38)}{2.11}\ \text{IMPRV} \qquad R^2 = .408$$

The magnitude of the improvement in housing quality thus had no apparent impact on a direct, although imprecise, measure of physical health.

This result is consistent with that of one of the most recent and sophisticated of the housing/health studies, covering the experience of 300 rehoused Negro families in Baltimore.[3] The study used the same test/control methodology as the present one and covered a period of about the same length. The investigators found that although there was an improvement in the health of rehoused children, there was little improvement in disease incidence among persons in the 35-59 age group. The present study, of course, is concerned exclusively with males of about 30-50 years.

Although the total number of outpatient visits made by test group workers was not changed by rehousing, visits made for two categories (out of 17) of disease types showed sharp drops after rehousing. Visits attributed to infective and parasitic diseases and to diseases of the digestive system fell by about 50 percent following rehousing. A complete listing of the various categories of diseases involved may be found in Appendix II. The increases in visits which offset the declines in these two categories were distributed over a large number of categories, with no dramatic increase in any single one.

Components of Housing Quality Change

The equal weighting given the quality change variables is quite

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[3] D. M. Wilner, R. P. Walkley, T. C. Pinkerton, and M. Tayback, The Housing Environment and Family Life, Baltimore, Johns Hopkins Press, (1962).

artificial. Better bathing facilities may have more or less effect on health than does improved garbage collection. Attempts to assign more precise weights to these variables involve one of the thorniest problems in the housing/health literature - the isolation of particular housing features which are related to health. Our analysis seeks to determine if one feature or some related group of features was associated with health changes and to estimate the degree of that association. This has important implications for housing policy, since we live in a world of scarcity. It is utopian to believe that sufficient funds will be made available to bring any appreciable portion of the world's poor housing up to even the minimum standards set by the United Nations and other agencies. Research must determine whether there are promising returns to incremental changes in the housing environment and, if so, the forms these changes might take. The present study investigates whether tradeoffs can be found between, say, more space and private bathing facilities when limitations of funds make a choice between the two necessary.

The housing environment can adversely affect health by (1) creating a predisposition to a disease or injury, or (2) causing a disease or injury directly, or (3) transmitting causes of disease, or (4) influencing the course of a disease or injury. Poor housing may mean exposure to cold and dampness or may produce fatigue, thus creating a predisposition to a disease like tuberculosis. Accidents often occur in the home or are brought on by stresses induced by the home environment. Housing may be important in the transmission of the so-called

crowding and filth diseases, such as typhus, trachoma, dysentery and typhoid. Finally, overcrowding and/or insanitary housing can delay recovery from an existing disease or injury.[4]

Figure 4 illustrates some specific mechanisms through which better housing is thought to be related to improved health. The measures of housing quality are in the form of changes between former and present housing. Thus, if BATH is positive for a given family, an improvement in bathing facilities is indicated. All variables except those measuring changes in persons per room (CHPRM) and in housing cost per person (COSPR) are dummy variables. The list is not meant to be exhaustive but does represent those areas of housing quality in which Loma Jardin residents experienced the most substantial change. Since the variables are measures of quality improvement, we expect them to be negatively correlated with changes in absences and in outpatient visits.

The variable COSPR (change in housing cost per person) represents an attempt to measure the more intangible elements of housing quality. Assuming competition in the housing market, we would expect housing quality per person to be a rising function of per capita housing expenditures. Location, aesthetics, and soundness of construction as well as housing features determine the cost or rent of the dwelling. Families which experienced the greatest rise in cost per person may be assumed to have also experienced the greatest increase in home quality per person. They must, however, cut other expenditures, possibly

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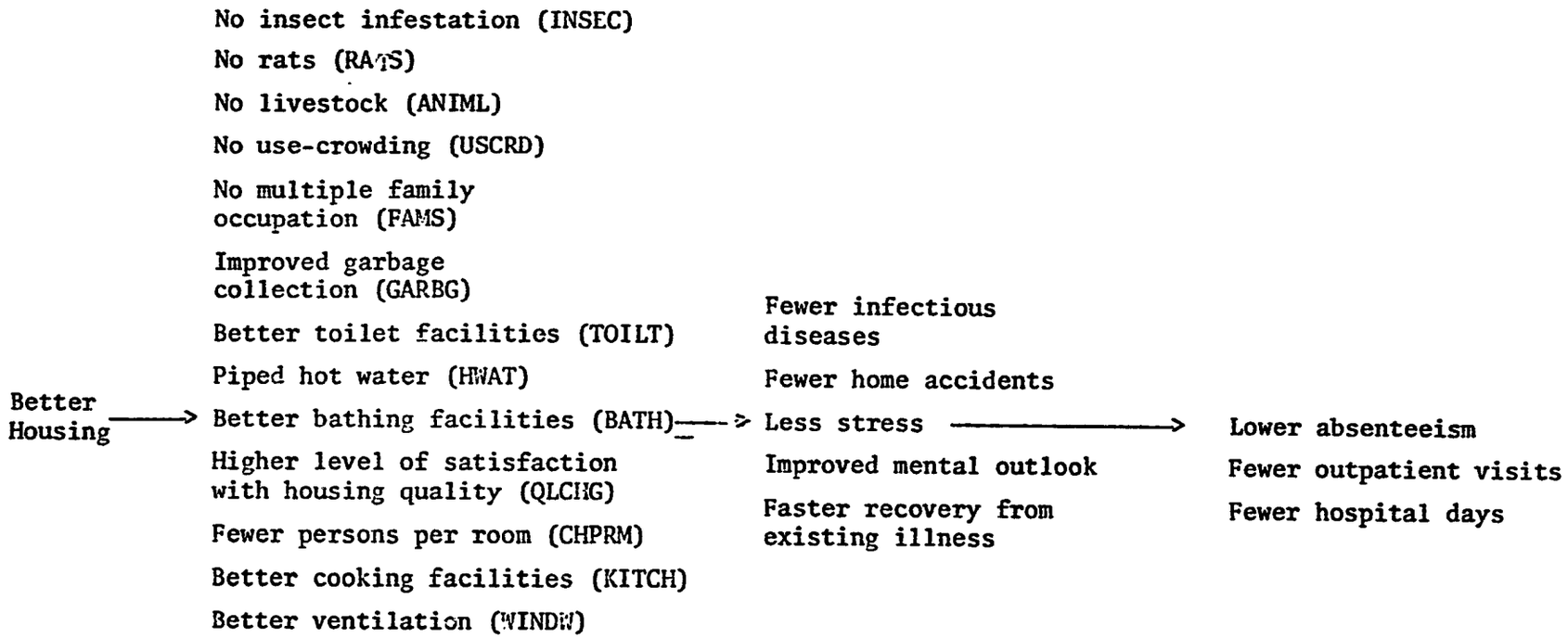
[4]Betty S. Hoffenberg, IHPS memo, June 14, 1967

FIGURE 4

HOUSING AND HEALTH MECHANISMS



A number of other relationships were postulated but could not be tested in Zacapu because there was no evident change in them before and after rehousing. Among these are travel to work, relations with neighbors, electricity, heat and type of cooking fuel.

including food and clothing, to pay the added cost of the new housing. The sign of COSPR is thus not known a priori. If COSPR is a measure of housing quality, it will be negatively related to changes in absences and outpatient visits; if it is a measure of financial stringency, the relationship will be positive.

In an attempt to quantify some of the housing/health mechanisms the changes in individual test group absences between 1964/65 and 1966/67 were regressed against the 14 quality change variables.[5] The result is as follows:

$$\Delta \text{ absences (1966/67 - 1964/65)} = -16.72 + \underset{(12.05)}{3.99}\ \text{INSEC} - \underset{(11.16)}{14.85}\ \text{RATS}$$
$$+ \underset{(16.66)}{26.29}\ \text{USCRD} - \underset{(20.13)}{20.79}\ \text{FAMS} + \underset{(13.44)}{3.54}\ \text{GARBG} + \underset{(14.89)}{15.00}\ \text{TOILT}$$
$$+ \underset{(18.29)}{37.65}\ \text{HWAT} - \underset{(21.32)}{25.33}\ \text{BATH} - \underset{(11.05)}{1.12}\ \text{QLCHG} + \underset{(10.88)}{6.90}\ \text{KITCH}$$
$$+ \underset{(10.77)}{4.27}\ \text{WINDW} - \underset{(10.07)}{5.44}\ \text{CHPRM} + \underset{(0.35)}{0.53}\ \text{COSPR} \qquad R^2 = .270$$

The only variable having a coefficient significantly different from zero at the .05 level is HWAT, which represents the acquisition of piped hot water by those who did not have it in their previous home. Since it is positively signed, the acquisition of hot water is associated with an increase in absences. This "wrong" sign cannot be blamed on multicollinearity (intercorrelation of the independent variables) since the simple correlation of HWAT with the change in absences is also positive (.315) and significant at the .05 level. HWAT may, however, be correlated with the residual. There is no discernable theoretical reason why this variable

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[5] ANIML (which measures changes in livestock raising) is not included because its coefficient lacks significance at the .99 level. Standard errors are in parentheses. n = 46.

should be signed in this way.

A similar regression compared the change in outpatient visits to the change in the same 14 quality variables[6] :

$$\Delta \text{ outpatient visits (1966/67 - 1964/65)} = 0.41 + \underset{(2.86)}{1.06}\ \text{INSEC}$$

$$- \underset{(2.75)}{5.52}\ \text{RATS} + \underset{(3.27)}{4.05}\ \text{ANIML} + \underset{(3.28)}{4.29}\ \text{USCRD} + \underset{(3.16)}{4.32}\ \text{GARBG} + \underset{(3.68)}{3.76}\ \text{TOILT}$$

$$- \underset{(4.00)}{1.20}\ \text{BATH} + \underset{(2.82)}{1.93}\ \text{QLCHG} - \underset{(2.85)}{1.63}\ \text{KITCH} - \underset{(2.89)}{0.41}\ \text{WINDW} - \underset{(0.08)}{0.03}\ \text{COSPR}$$

$$R^2 = .278$$

The only variable significantly (.05 level) related to the change in outpatient visits is RATS (representing the elimination of rat infestation). As expected, the variable is negatively signed, indicating that the elimination of rats was associated with a decline of 5.5 outpatient visits over a two year period for each person experiencing this particular improvement in quality.

The negative sign and lack of statistical significance of the variable COSPR (change in housing cost per person) sheds doubt on the proposition that the higher cost of housing caused such large reductions in non-housing expenditure that health was adversely affected.

In short, changes in particular facets of housing quality were not associated with changes in health. This was true when health was measured both by outpatient visits and by absences attributed to illness. On the basis of evidence from this case study, it appears that changes in individual housing features or services will not result in changes in health. The elimination of rats is a possible exception to this statement and may

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[6] FAMS, HWAT, and CHPRM not included because they lack significance at the .99 level. n = 46.

provide one opportunity for improving health through incremental improvement of the environment.

VII. SUMMARY -- REHOUSING AND BEHAVIOR

This study was introduced by the presentation of a simple housing/health hypothesis--that improvements in housing quality lead to measurable improvements in the physical health of workers and consequently to increases in their productivity on the job. A corollary of this hypothesis asserted that the magnitude of these improvements is a positive function of the magnitude of the improvement in housing quality. The empirical evidence collected in Zacapu indicates that changes in the housing environment, even if carefully controlled to eliminate complicating changes in other parameters, have an impact which was not explained by this simple hypothesis. Rehousing was found to result in no significant reduction in outpatient visits to a free medical facility. The magnitude of the change in housing quality experienced by individuals in the sample was unrelated to individual changes in outpatient visits. The demand for inpatient (hospital) care was also unchanged by rehousing.

Although these crude measures of physical health were not changed by rehousing, absences attributed to illness rose sharply among test group workers during the first year after rehousing, then returned to "normal" levels in the second. This rise and decline was tentatively attributed to the higher productivity of test group workers in the "household sector". The household sector includes the performance of those tasks associated with moving into a new home, such as landscaping, the construction of walls and patios, and other home improvements. It was observed that these activities were very common among rehoused workers. It is believed that additional absences were taken by rehoused workers in order to devote

additional time to activities in this "household" sector and were falsely reported as due to illness. It was hypothesized that the stock of possible home improvements became exhausted, causing marginal labor product in the household sector to fall in the second post-rehousing year, removing the incentive for feigning illness.

Several other hypotheses advanced to explain the increase in absences were tested and rejected. It was impossible to reject completely, however, the proposition that rehoused workers increased their absence/illness ratio because the new home was a more attractive place in which to recover, although this explanation is not consistent with the temporary nature of the rise in absences.

Productivity on the job rose significantly (relative to that of a non-rehoused control group) among a sample of 10 test group workers during the first year after rehousing. The increase, however, was only temporary. It was hypothesized (Section V, pp. 42-43) that this productivity increase was due to an attempt by workers to maintain a desired money income level while increasing time worked in the household sector. The observation that incentive system workers experienced a greater rise in absenteeism than did non-incentive workers is evidence that the housing/productivity mechanism took this form, since only incentive workers had the opportunity to make up income lost through absenteeism by raising their work effort and consequent bonus payment.

A slightly different mechanism, also consistent with the data, attributes the temporary rise in productivity to an attempt by test group workers to equalize their marginal products in the factory and "household" sectors by changing the work effort expended in each. Incentive workers, under this explanation, attempted to raise their productivity on the job

to equal their initially higher marginal product in the household sector. Both mechanisms are consistent with the temporary nature of the productiviy increase. The first asserts that marginal labor product in the home fell in the second year after rehousing, causing absenteeism to fall, thus removing the stimulus to work harder to maintain a desired income. The second mechanism asserts that the fall of marginal labor product in the home caused workers to decrease their effort on the job in order to again equalize marginal products.

The failure of worker health to respond to improved housing may be due to any one, or a combination of, four factors--

(1) Lack of a relationship between housing and health for persons in the age group covered,

(2) Initial housing level "too high",

(3) Initial health level "too high",

(4) Insufficient time allowed for the effects of rehousing to become apparent.

The first factor has been discussed on page 52 above with reference to the Wilner study. That study found little improvement in disease incidence among persons in the 35-59 age group. The Zacapu study has been concerned only with male heads of households aged 30-50. This factor may explain the variance of the present results from those of IHPS studies in Pine Ridge, South Dakota and Hambaek, Korea, which showed health gains for families after rehousing.[1]

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[1] Leland S. Burns, "Cost-Benefit Analysis of a Social Overhead Project for Regional Development," op. cit.; B. Khing Tjioe, Report on Productivity in Relation to Housing Conditions and Community Facilities in Hambaek, Korea, International Housing Productivity Study, Graduate School of Business Administration, University of California, Los Angeles (1966), pp. 39-44.

The second factor is also relevant to comparisons with the previous case studies. The former housing in Zacapu was quite bad by the standards of most modern industrial societies. Nevertheless, it was far superior to the level of the Pine Ridge housing, which has been termed "as derelict as any in the nation and comparable even to the worst found in many backward parts of the world."[2] Nor did it resemble the Hambaek housing, where 4.6 persons occupied a single room on average before housing,[3] compared to 1.7 persons per room in the "before" housing in Zacapu. If the response of health to housing change is a function of the initial level of housing, the results in the Zacapu study would be expected to be less dramatic than those in either of the other studies cited.

Similarly, the response of workers to rehousing may depend on their initial level of health. The availability of free medical care and its rather intensive utilization for minor illnesses indicate that medical care may have to some extent substituted for quality housing in determining an initial level of health higher than that indicated by the quality of the initial housing stock.

The fourth possible reason for the lack of a positive health response is that the two years allowed after rehousing (along with a two-month "adjustment period") may have been too short a time for such a response to become apparent. Although the Pine Ridge and Hambaek studies showed positive health effects within one year after rehousing, conditions peculiar to Zacapu, such as the age composition, initial housing level,

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[2]B. Khing Tjioe and Leland S. Burns, "Does Good Housing Contribute to Sound Economic Development?" Journal of Housing, Feb.-March 1967, p. 88.

[3]Ibid., p. 88.

and initial health level of rehoused workers may have made a longer period of time necessary if health improvements were to appear.

The use of absenteeism as a measure of the level and change in physical health was discussed in Section V of this report. It was concluded that the dependence of absenteeism on labor/leisure preferences and on changes in the economic opportunities and in the budget constraints faced by workers make it a relatively poor proxy for more direct measures of health.

Data presented in Section VI indicate that persons who complained of rat infestation in their previous home experienced a significant decline in outpatient visits after rehousing in rat-free homes. The change in outpatient visits associated with the elimination of rats amounted to 5.5 visits per person over a two year period. None of 13 other variables representing changes in various aspects of housing quality was significantly related to changes in outpatient visits. Thus the elimination of rats seems to offer the greatest possibilities for improving health through incremental changes in the housing environment.

Rehousing was associated with sharp declines in the number of outpatient visits required for infectious and parasitic deseases and diseases of the digestive system. Although the small numbers involved make the significance of this finding doubtful, there appear to be some grounds for speculating that improvements in the purity of the water supply may have been involved. A listing of categories of diseases for which visits to the clinic were made before and after rehousing is presented in Appendix II.

The study failed to prove that the construction of Loma Jardin generated substantial and permanent benefits which could be recaptured by

the firm "investing" in worker housing. The company share in the additional productivity of those workers paid under the incentive system was estimated at 108.2 pesos per worker per month during the first year after rehousing. Depending on the value attached to the loss of production due to an absent worker, the increase in absenteeism following rehousing offset all or part of this gain. In fact, we have noted above that the most consistent explanation for the productivity increase depends upon the prior existence of an increase in absenteeism. After the initial post-rehousing year, both costs and benefits to the company fell to zero.

The usual strictures on generalizing from case studies of course apply here. The test and control groups were matched only on department and length of tenure and differed sharply in their average pre-rehousing absence rates, although not in number of outpatient visits. The low coefficients of determination found in the regressions relating housing changes to changes in health and productivity indicate that the unexplained portion of behavior is large. The productivity measure, which used work group output as a proxy for individual output, was less than ideal. Had additional resources been available, it would have been useful to examine the health response of families of rehoused workers and to extend the length of the post-rehousing period. Another possible area of research involves the determinants of industrial absenteeism. Perhaps the addition of certain variables such as job type and work history would have improved the ability of the analysis to explain changes in absenteeism.

Despite its limitations, it is hoped that this study has provided some insight into possible housing/health and housing/productivity mechanisms and into the industrial worker's relationship with the complex environment in which he lives.

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APPENDIX I

ZACAPU QUESTIONNAIRE

Name_____ Type of house_____

Present address_____ Previous address_____

Present House

(1) How many people live in this house?_____

(2) How many families?_____

(3) Do any family members sleep in the living room or dining room here?_____

(4) What fuel is used for cooking?_____

(5) What fuel is used to heat the rooms?_____

(6) How many rooms are heated?_____

(7) Do you have problems with insects?_____

(8) IF YES, with what type?_____

(9) Do you have problems with rats?_____

(10) Does your family keep animals other than dogs and cats?_____

(11) IF YES, where are they kept?_____

(12) What do you like about your present house?_____

_____

_____

_____

(13) What do you dislike?_____

_____

_____

_____

(14) Why did you move from your last house to this one?_____

_____

_____

_____

Former House

(1) How many rooms did you have in your last house, counting the kitchen but not the bathroom nor corridors?_____

(2) How many bedrooms?_____

(3) How many people lived in the former house in the year in which you moved?_____

(4) How many families lived in the former house?_____

(5) Did you have running water piped inside the house?_____

(6) IF NO, how many families shared the same water spigot?_____

(7) Did you have piped hot water in the former house?_____

(8) Did you have electricity?_____

(9) IF YES, in every room or only in the living room?_____

(10) Did you have garbage collection service at the former house?___

(11) IF YES, how often was the garbage collected?_____

(12) What fuel was used for heating the rooms?_____

(13) How many rooms were heated?_____

(14) Was there a separate kitchen in the former house?_____ Where was it located?_____

(15) What fuel was used for cooking?_____

(16) Were there windows in the kitchen?_____ In the bedroom?____

(17) Did you have problems with insects in the former house?_____

(18) IF YES, with what types?_____

(19) Did you have problems with rats?_____

(20) Did you have a private toilet inside your former house?_____

(21) IF NO, did you have a private toilet outside your former house?

_____

(22) IF NO PRIVATE TOILET, with how many families was the toilet shared?_____

(23) Did any family members sleep in the living room or the dining room?_____

(24) Did you have a private bath or shower in the former house?_____

(25) IF NO, with how many families were they shared?_____

(26) Did your family keep animals other than dogs and cats?_____

(27) IF YES, where were they kept?_____

(28) What did you like about the former house?_____

_____

_____

_____

(29) What did you dislike?_____

_____

_____

_____

(30) In general, which house do you like most, the present or the former?_____

Financial and Miscellaneous

(1) Did you rent or own the former house?_____

(2) IF RENTED, what was the monthly rent?_____

(3) IF OWNED, for how much was it sold?_____

(4) How much time did it take you to go from the former house to work at the Celanese plant?_____

(5) And now?_____

(6) How long did it take your children to go from the former house to their school?_____

(7) And now?_____

(8) What were the neighbors like in the former neighborhood?_____

_____

(9) What are the neighbors like here?_____

_____

(10) Of all the houses in which you have lived since you were married, which do you prefer?_____

_____

_____

RESPONSES TO HOUSING QUESTIONNAIRE

Present House

(1) Mean number of persons per house	6.52	Rooms per house	5.18
		Persons per room (unweighted)	1.28

(2)	One family	48	More than one family	2
(3)	Use living room for sleeping	4	Do not use living room for sleeping	46
(4)	Use natural gas for cooking	50		

(5-6) None of the 50 families heated the rooms. The mean high temperature for Morelia, Michoacan, which is about 35 miles from Zacapu, is 75.0 F. while the mean low is 43.3 F. Zacapu residents claimed that heat was not necessary, since it dipped below freezing only a few times each year and then only at night. They admitted, however, that the change in temperature between day and night increased colds during the winter season. The houses are not equipped with central heating and small electric heaters would not be economical.

(7-8) Almost all Loma Jardin residents complained of flies and, to a lesser extent of mosquitos and spiders. The windows are unscreened and little effort seemed to be made to keep flies out of the houses. Only 3 out of 50 residents complained of roaches. Since there are flies in both Loma Jardin and Zacapu center, the change in insects used in the regression refers only to changes in cucarachas (roaches), pulgas (fleas), chinches (bedbugs), and other insects of this type.

(9) Only one resident complained of rat problems in Loma Jardin. Mice often entered homes from the nearby plowed fields. Nine of 50 residents complained of mice. Because of the rural nature of the surroundings, mice were not considered disease carrying for purposes of the regression. When the questionnaire was given, mice

(ratones) and rats (ratas) were carefully distinguished.

(10-11) Seven residents kept chickens while one kept rabbits. The animals generally were kept in cages in the backyard. In no case were animals owned by residents allowed to roam the house or frontyard. Cows were kept in the unfenced plowed fields adjoining the project and two residents complained of wandering cows. There seemed to be too few cows in too large an area to warrant any danger to health.

(12)

Comfortable	21
Environment; fresh air; view	18
Services (utilities, bath)	10
Modern; functional; good distribution of space	8
Owns the house	8
Rooms communicate	7
Good neighbors	3
Larger than old house	2
Neither hot nor cold	2
Garden	2
Nothing	2
Other	6

Note: More than one answer per person allowed.

(13)

Nothing	20
Distance to town; transportation	9
Rooms too small	7
Leaks in roof	4
Badly constructed	4
Ceiling too low	3
Bad distribution of space	3
Wandering animals; animal smell	2
Badly painted	2
Flood	2
Other	3

Note: More than one answer per person allowed.

(14)

Chance to own a house; payment system	41
Bad conditions at old house	5
To improve living conditions in general	3
Husband decided to move	1

Note: Only one answer allowed per person. The chance to own a house under these circumstances seemed to have considerable appeal. Sr. Arreola of Construccion Popular confirmed this intensity of desire for homeownership, stating that the 20% downpayment required by lending agencies was the major obstacle to a vastly expanded housing demand. In particular, fairly high salaries among Celanese workers and a small town setting left them with little on which to spend additional income and they welcomed the chance to make an investment of this type. The fact that most people did not move because of bad conditions in previous housing indicates, however, that many may actually have suffered a decline in housing quality for the sake of homeownership.

Former House

(1-3)	Mean number of persons per house	6.46	Rooms per house Persons per room (unweighted)	4.22 1.70
(4)	One family	43	More than one family	7
(5-6)	Running water inside the dwelling unit	47	Running water outside the dwelling unit	3
(7)	Hot water	34	No hot water	16

Note: The Loma Jardin houses, as well as most of the previous houses, do not have a constantly running supply of hot water. A small hot water heater, burning gas, petroleum, or wood, and called a "calentador" provides water for bathing and is fired as needed.

(8-9) All the previous houses, like the present ones, had electrical outlets in all rooms.

(10-11)	Daily collection	38
	One or two times weekly	8
	Three times weekly	2
	No collection	2

(12-13) None of the previous houses were heated.

(14)	Separate kitchen inside house	29
	Kitchen across patio	20
	No separate kitchen	1
(15)	Natural gas	48
	Wood	1
	Petroleum	1

(16)	Windows in kitchen	39	Windows in bedrooms	39
	No windows in kitchen	11	No windows in bedrooms	11
(17-18)	Roaches	10		
	Fleas	5		
	Bedbugs	3		
	Head lice	1		

Note: More than one answer per person allowed.

(19)	Rat problem	30
	Mice only	10
	Neither rats nor mice	10

Note: In the regression, a change in "rat problems" was taken to mean a change from "rat problems" in the former house to "no rats" or "mice only" in the present house.

(20-22)	Private toilet inside	41	Private toilet outside	8
			No private toilet	1
(23)	Used living room for sleeping or no living room	18	Did not use living room for sleeping	32
(24-25)	Private bath	38	No private bath	12
(26-27)	No animals nearby	33		
	Complained of neighbors' pigs	6		
	Kept chickens only	9		
	Kept pigs and chickens	1		
	Kept pigs only	1		
(28)	Central location	23		
	Large	13		
	Nothing	8		
	Trees or garden	6		
	Good neighbors	2		
	Well ventilated	2		
	Tiled porch or patio	2		
	Other	6		

Note: More than one reply per person allowed.

(29)	Bad distribution of space, rooms did not communicate	12
	Leaks	8
	House was old	8
	Did not own	7

Nothing	6
Lack of services	5
Uncomfortable	5
Too small	4
Too cold	4
Animals kept nearby	3
Too large	2
No living or dining room	2
Adobe construction	2
Too hot in summer	2
Lack of light	2
Other	16

Note: More than one reply per person allowed.

(30)	Prefer present house	48	Prefer former house	2

Financial and Miscellaneous

(1)	Rented former house	41	
	Former house belonged to relatives	5	
	Owned former house	4	
(2-4)	Average payment in present house	351.64	pesos/mo.
	Average rent in former house	214.50	"
	Payment/room in present house	67.88	pesos/mo.
	Rent/room in former house	50.83	"
	Payment/person in present house	53.93	pesos/mo.
	Rent/person in former house	33.20	"

Note: Rent was imputed on the basis of 0.9% of value of house per month for persons who owned the former house or rented from relatives at a below market rate.

(5-8) These questions were dropped when it was discovered that the availability of union provided bus transportation for workers and school children made the difference in travel time negligible.

(9)	Complaints about former neighbors	3	No complaints	47
(10)	Positive comments about present neighbors	7	Present neighbors "equally good"	43

(11)	Prefer present house	41
	Prefer some other house in which they have lived	6
	Prefer former house	2
	Like present and former house equally well	1

APPENDIX II

LEVELS OF HEALTH AND ABSENTEEISM IN ZACAPU

The state of Michoacan has a somewhat better health record than does Mexico as whole. The 1964 death rate for Michoacan[1] was 8.7 per thousand while that for Mexico was 10.3. These rates should not be compared with rates for other countries because of the skewed age composition of the Mexican population. The infant mortality rate is more susceptible to comparison -- it stood at 47.3 for Michoacan and 66.3 for the country as a whole (per thousand births). The corresponding rate for the U. S. was 24.8 (1964).[2] The Michoacan rate is about equal to that experienced in the U. S. in 1940.[3]

An American nun and two volunteer American nurses operate the Clinica San Vicente in Zacapu, which dispenses free medical care to the very poor. They say that Zacapu's major health problem is diarrhea, which can have many complications, particularly among the young. Respiratory diseases are common, especially in winter. There is some typhoid but not among Celanese workers, who are vaccinated by the factory.

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[1]Mexico. Direccion General de Estadistica. Anuario Estadistico Compendiado, 1964. p. 30.

[2]U.S. Department of Commerce, Bureau of the Census. Statistical Abstract of the U.S., 1966, Table 64. (Washington: 1966), p. 55.

[3]U.S. Department of Commerce, Bureau of the Census. Historical Statistics of the U.S., Series B 101-112, (Washington: 1957), p. 25.

Many of the diseases can be laid to the quality of the water, which is pure originally but which becomes contaminated in the antiquated system of pipes.

Under the social security legislation enacted in 1942, Mexican workers covered by the Instituto Mexicano del Seguro Social are entitled to free medical services, including "general and specialist care, surgery, maternity care, hospitalization or care in convalescent homes, medicines, laboratory services, dental care, and appliances."[4] Insured persons contribute 2.25% of the first 80 pesos earned daily while the employer adds an additional 5.6%. Medical services are ordinarily provided by clinics and hospitals set up by the Institute. In addition to medical care for the worker and his family, sickness benefits of 60% of earnings are paid after a 3 day waiting period. The benefits may be collected for up to 78 weeks.

The Zacapu facility of the I.M.S.S. is a modern one-story structure built in 1962. It is well maintained and staffed by medical doctors. A pharmacy is maintained on the premises. From the quality of the medical records, it is apparent that careful diagnoses are made. Medicines are prescribed in adequate, perhaps even excessive, quantities. Because of the small size of the facility (about 20 beds) and the lack of certain specialists, persons requiring some types of surgery or other treatment must be referred to hospitals in Morelia, about 40 miles

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[4]U.S. Social Security Administration, Office of Research and Statistics, Social Security Programs Throughout the World (1967) pp. 148-49.

away. The intensive use made of the facility by persons with minor ailments indicates that service is readily available when needed. The medical care to which Celanese workers have access is higher in both quantity and quality than that available to townspeople not covered by the social insurance system.

In an effort to determine the effects, if any, of rehousing on particular diseases or categories of diseases the medical records of 46 test and control group members over the four year period covered by the study were examined in some detail. A fairly elaborate medical chart is kept for each patron of the I.M.S.S. clinic, including a description of each inpatient and outpatient visit. A local doctor assisted the author in categorizing these visits according to the standard classification system of the World Health Organization.[5] The diseases were initially recorded on a four digit level of aggregation, then combined into 17 categories. The results for outpatient visits are summarized in Table A-1.

In each category is placed the total number of visits attributed to a particular type of disease among each group for the year in question. This was done in order to weight the severity of illness, i.e., a disease requiring 5 visits is assumed to be 5 times more severe (or expensive) than a disease requiring only a single visit. The individual observations (visits) are thus not independent of one another.

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[5]World Health Organization. Manual of the International Statistical Classification of Diseases, Injuries, and Causes of Death. Vol. I, Geneva, 1955 revision (1957).

TABLE A-1

OUTPATIENT VISITS CLASSIFIED BY DISEASE GROUP

WHO Classification	Disease Group	Before Rehousing (1964-65)		After Rehousing (1966-67)	
		Test	Control	Test	Control
0010-1399	Infective and parasitic diseases	53	56	19	65
1400-2399	Neoplasms	1	8	5	0
2400-2899	Allergic, endocrine system, metobolic, and nutritional diseases	18	22	22	22
2900-2999	Diseases of the blood and blood-forming organs	1	0	0	0
3000-3299	Mental, psychoneurotic, and personality disorders	15	37	23	46
3300-3999	Diseases of the nervous system and sense organs	24	27	29	11
4000-4699	Diseases of the circulatory system	5	8	9	11
4700-5299	Diseases of the respiratory system	77	115	80	124
5300-5899	Diseases of the digestive system	76	71	40	82

TABLE A-1 (continued)

WHO Classification	Disease Group	Before Rehousing (1964-65)		After Rehousing (1966-67)	
		Test	Control	Test	Control
5900-6399	Diseases of the genito-urinary system	4	14	7	4
6400-6899	Deliveries and complications of pregnancy, childbirth, and the puerperium		(1)		
6900-7199	Diseases of the skin and cellular tissue	3	5	15	20
7200-7499	Diseases of the bones and organs of movement	15	35	22	35
7500-7599	Congenital malformations	0	0	0	0
7600-7799	Certain diseases of early infancy		(1)		
7800-7899	Symptoms, senility, and ill-defined conditions	38	19	52	20
	Accidents, except athletic	42	44	36	40

(1) Category not applicable to a population composed of adult males.
Note: Two test and one control group member omitted because doctors felt they were misrepresenting their symptoms, leading to false diagnoses. Thus total visits do not add to totals given in Table 3.

Because of the small number of individuals making visits in each category, no attempt at testing the statistical significance of the changes was made.

We may, nevertheless, make some observations about general trends in the data. After rehousing, there were sharp declines among test group workers in the number of visits made for infective and parasitic diseases (down 64%) and for diseases of the digestive system (down 47%). During the same period, control group visits for these categories actually increased. Unfortunately, the standard categories are ordered by type of disease rather than by type of causation (waterborne, carried by insects, etc.). Had such a categorization been possible, trends in disease incidence might have been clearer. The major part of the decline in infective and parasitic diseases took place in infectious hepatitis (WHO 092), "other protozoal dysentery" (WHO 047), and gonorrhea (WHO 030). The control group did not show declines in visits attributed to these diseases. The number of visits involved for each disease, of course, is very small. Since hepatitis and dysentery may be waterborne, it is possible to speculate that the water mains and pipes installed in Loma Jardin may have improved the quality of the water and contributed to a fall in the incidence of these illnesses. The major part of the test group decline in diseases of the digestive system occurred in ulcers of the stomach (WHO 540), a category for which control group workers showed an increase in visits.

The company has consistently applied a very strict policy with respect to absenteeism. Since the beginning of production the rate has never exceeded 7 percent, and by 1959 it stood at a rather commendable

4 percent. In the early days of construction in the late 1940's, laborers exhibited a backward bending supply curve. With wages 2 to 3 times higher than the prevailing agricultural wage the factory worker could earn the same income with much less effort. The personnel manager claimed that -- "Only gradually as the workers' personal, material demands increased did the problem resolve itself, that the workers would consistently present themselves at work."[6]

The company policy of triple time pay for holidays reduces absenteeism on those days but absenteeism is high during the week-long fiesta called Topa, on Jose Maria Morelos' birthday on September 30, when many go to the state capital at Morelia for celebrations, and during the 9-day long pre-Christmas Posada. There is no pattern of absenteeism according to Burleson.[7] There are a few workers who have 18 to 20 absences a year and there are others who have many years of perfect attendance. Management and workers agree that if a man were used to drinking, the higher income from his factory job would help him indulge his habit and give him the financial opportunity to miss work on "San Lunes", Saint Monday, the day of hangovers. Agriculturalists tend to be absent during the planting season, although the relatively high wages in the plant make it more economical to hire someone else to do the farm work.

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[6]Noel David Burleson, Proletarian Perspectives -- An Anthropology of Industry, Unpublished Ph.D. thesis, Harvard University, Department of Social Relations, 1964, p. 53. The thesis is a study of the human effects of the construction of the Celanese plant in Zacapu.

[7]Ibid., p. 54.

APPENDIX III

ZACAPU IN THE MEXICAN HOUSING CENSUS

Municipio of Zacapu	Urban houses	58.84%	Rural houses	41.15%

Urban only

Avg. family size	5.44	Homeowners	48.48%
		Renters	51.52
2 rooms or less	77.51% of the houses		
	73.20% of the people		

Urban and Rural

Primary material of walls		
	Adobe	73.24%
	Wood	5.16
	Tabique	15.73
	Block	.85
	Other	5.01
Water piped inside dwelling		32.84%
Water piped outside		8.16
No water		59.00
Have drainage or sewer		37.52%
Have bathroom with running water		14.38%
Fuel used for cooking		
	Wood or coal	76.06%
	Petroleum	12.64
	Gas or Elec.	11.29

SOURCE: Mexico. Direccion General de Estadistica. VIII Censo General de Poblacion, 1960. Estado de Michoacan.

APPENDIX IV

STATISTICAL CALCULATIONS

IV-1 Chi-square test of change in bonus per day between 1965 and 1966.

	Higher Bonus	No Improvement	
Test	Act. 9 Exp. (6.5)	1 (3.5)	10
Control	4 (6.5)	6 (3.5)	10
	13	7	

$$X^2 = \frac{(2.5)^2}{6.5} + \frac{(2.5)^2}{6.5} + \frac{(2.5)^2}{3.5} + \frac{(2.5)^2}{3.5} = 5.49$$

Significant at .05 level.

Since the expected frequencies in each cell were low, the exact probability of accepting H_1 (that more test than control members increased their bonus) when H_0 (no difference) was true was calculated for a non-continuous distribution. This probability was found to be .029 for a one tailed test. Method described in Pearson and Hartley, Biometrika Tables for Statisticians, pp. 65-72.

IV-2 Chi-square test of change in absenteeism between 1965 and 1966.

	Improved Record	No Improvement	
Test	Act. 19 Exp. (21.5)	31 (28.5)	50
Control	24 (21.5)	26 (28.5)	50
	43	57	

$$X^2 = \frac{(2.5)^2}{21.5} + \frac{(2.5)^2}{21.5} + \frac{(2.5)^2}{28.5} + \frac{(2.5)^2}{28.5} = 1.02$$

Not significant at .05 level

IV-3 Chi-square test of change in number of outpatient visits before (1964-65) and after (1966-67) rehousing.

	Improved Record	No Improvement	
Test	Act. 23 Exp. (19.5)	23 (26.5)	46
Control	16 (19.5)	30 (26.5)	46
	39	53	

$$X^2 = \frac{(3.5)^2}{19.5} + \frac{(3.5)^2}{19.5} + \frac{(3.5)^2}{26.5} + \frac{(3.5)^2}{26.5} = 2.18$$

Not significant at .05 level

IV-4 Chi-square test of number of persons spending one or more days in the hospital before (1964-65) and after (1966-67) rehousing.

		Before	After	
Test	Act.	1	6	7
	Exp.	(2.2)	(4.8)	
Control		4	5	9
		(2.8)	(6.2)	

$$\chi^2 = \frac{(1.2)^2}{2.2} + \frac{(1.2)^2}{2.8} + \frac{(1.2)^2}{4.8} + \frac{(1.2)^2}{6.2} = 1.69$$

Not significant at .05 level

Exact test not significant at .05 level -- See Pearson and Hartley, op. cit., pp. 65-72.

APPENDIX V

CORRELATION MATRIX FOR HOUSING QUALITY VARIABLES

	RATS	USCRD	FAMS	ANIML	GARBG	TOILT	HWAT	BATH	QLCHG	KITCH	WINDW	CHPRM	COSPR	Δoutpatient visits	Δabsences
INSEC	.272	.271	-.012	-.018	.058	.058	-.054	.251	.042	-.215	.069	.030	-.017	.064	-.031
RATS		.142	.209	.122	-.069	.037	.088	.064	.088	.038	-.105	.293	.271	-.273	-.139
USCRD			.281	.009	-.029	.083	.174	.490	.174	-.170	.202	.565	.123	.211	.204
FAMS				.211	-.204	-.048	.259	.044	.124	-.275	.086	.231	.376	.005	.006
ANIML					-.073	.047	.190	.177	.190	.271	.234	.261	.010	.143	.179
GARBG						-.022	.279	.137	-.053	-.128	.255	-.105	-.139	.214	-.007
TOILT							.279	.489	.279	-.023	.117	.325	.065	.195	.194
HWAT								.657	.137	-.123	.256	.195	-.158	.156	.315
BATH									.251	-.172	.288	.320	-.076	.247	.229
QLCHG										-.123	.069	.288	-.005	.200	-.002
KITCH											-.213	.047	-.108	-.127	.014
WINDW												.001	-.060	.196	.187
CHPRM													.372	.106	.140
COSPR														-.130	.076

Note: This table presents simple correlations among the variables defined in Figure 2 as well as correlations of each of these with the changes in absences and in outpatient visits between the two years before and the two years after rehousing.