Male-Female Labor Force Participation and Rapid Industrialization

Carlos E. Santiago*

This paper investigates the determinants of changes in the labor force participation rate during a period of rapid industrialization. Short and long-term changes in age-sex specific participation rates for the Puerto Rican labor force are examined during the period 1947-1978.[1] Over this period of time the Puerto Rican economy exhibited rapid industrial growth, substantial net out-migration, an increase in capital-intensive manufacturing activities, and a dramatic rise in public sector employment. The resulting changes in economic structure were accompanied by the substitution of female for male labor within the economy as indicated by rising female labor force participation and, more significantly, by sharp and sustained declines in male labor force participation.

The purpose of this study is to inquire as to whether the various hypotheses regarding movements of aggregate labor force partici-

1 Among the studies examining the determinants of labor force participation in the context of time series analysis, as is done in this study, are those of Tella (1964), pp. 454-469 and Tella (1965), pp. 69-83; Thomas Dernburg and Kenneth Strand, (1964), pp. 378-391 and Thomas Dernburg and Kennth Strand (1966), pp. 71-95.; Pewter S. Barth (1968), pp. 375-382, Officer and P. Anderson (1969), pp. 278-287; Fair (1971), pp. 164-168.; Wachter (1972), pp. 141-151 and Wachter (1977), pp. 545-576.

pation in industrial countries are applicable to developing countries engaged in an "industrialization-first" development strategy. Although empirical studies of labor force participation behavior in modern industrial societies have a relatively long and rich history, much less emphasis has been placed on the responsiveness of labor force participation in developing countries to changing economic conditions in both the short and long-run.[2] In this regard, Puerto Rico provides a good, but unique, example. Among the competing short-run theoretical models that are examined are those of discouraged versus additional worker behavior in which cyclical variations in labor force participation are linked to changing employment opportunities. On the other hand, long-run movements in labor force participation are the result of trends in earnings for the various age-sex groups. The contrasting views regarding the impact of earnings are examined in this paper in terms of permanent and relative income models. Likewise, the effect of net migratory movements between Puerto Rico and the United States, so important in absorbing surplus labor during the island's industrial expansion, is accounted for in the analysis.

The paper is divided into four sections. In Part 1, overall trends in labor force participation in Puerto Rico during 1947-1978 are described, both in the aggregate and for individual age-sex groups. Part II presents and tests a short-run model of movements in labor force participation rates while Part III concentrates on a model explaining longer-run trends in this variable. Finally, Part IV provides conclusions and implications of the preceding analysis.

I. Trends in Labor Force Participation in Puerto Rico, 1947-1978

Many countries that have achieved an industrial economy exhibit a relatively unchanged aggregate labor force participation rate over time. But the constancy of the participation rate masks significant underlying trends in the behavior of different age and

2 Notable exceptions are the studies by John D. Durand, *The Labor Force in Economic Development* (Princeton University Press: Princeton, N.J., 1975); Guy Standing, *Labour force Participation and Development* (International Labour Office: Geneva, 1978); and the companion volume edited by Guy Standing and Glen Sheehan, *Labour Force Participation in Low-Income Countries* (International Labour Office: Geneva, 1978).

sex groups within the economy. For example, one trend not captured by the aggregate participation rate is the decline in male labor force participation. A second, perhaps more interesting trend, is in the female participation rate which has increased dramatically in almost all industrialized countries in the postwar period. Thus, the constancy of the aggregate labor force participation rate over time is due, in part, to off-setting trends in male and female participation rates.

Had it not been for the massive and unique migratory outflow of the 1950's, it is quite possible that trends in Puerto Rican participation rates would have been similar to the patterns described above. However, emigration was instrumental in the initial downward trend in the aggregate participation rate, falling as it did from approximately 55 percent in 1947 to a low of 48 percent in 1962 (see Table 1).[3] This is contrary to what occurred in many industrial and industrializing countries in the postwar era. It was

Table 1

LABOR FORCE PARTICIPATION RATES IN PUERTO RICO
BY SEX 1947-1977, FOR SELECTED YEARS
(IN PERCENT AND PERCENTAGE CHANGE)

Year	Both Sexes	Percent Change	Males	Percent Change	Females	Percent Change
1947	55.0	—	97.7	—	23.1	—
1952	55.4	0.73	98.7	1.02	25.3	9.52
1957	50.5	-8.84	91.8	-6.99	21.8	-13.83
1962	48.4	-4.16	91.7	-0.11	20.6	-5.50
1967	48.9	1.03	87.7	-4.36	23.9	16.02
1972	48.2	-1.43	81.8	-6.73	25.7	7.53
1977	44.9	-6.85	74.0	-9.53	25.0	-2.72

Soruce: Puerto Rico Department of Labor and Human Resources, Bureau of Labor Statistics, Household Survey, 1947-1977.

3 Information on the Puerto Rican labor force is compiled on a monthly basis by the Bureau of Labor Statistics of the Puerto Rico Department of Labor and Human Resources. The aggregate participation rate is calculated by dividing the number of employed and unemployed individuals 16 years of age and older by the total civilian non-institutional population 16 years of age and older.

precisely over this period that the absolute size of the Puerto Rican labor force was declining while population grew at a very slow rate. However, the rapid fall in the labor force participation rate during the 1950's was followed by a relatively constant participation rate during the decade of the 1960's. This pattern is more reminiscent of that of industrial economies at the time.

Disaggregating the rate of participation in Puerto Rico by sex gives rise to interesting patterns and helps explain the trend in the aggregate rate. For one thing, the male rate has continually declined over the industrialization period, even after the migratory net outflow diminished. This occurred at an even more rapid pace than the decline which took place in many industrialized countries.

The female participation rate has behaved quite differently from that of males. Although it did give evidence of a declining trend over the 1950 decade of substantial net out-migration, during the 1960's it has increased sharply. Just as occurred in many countries during that time, women were entering the labor force at very rapid rates. It seems likely that the initial fall in both male and female participation rates was due to the composition of the migratory flow during the early stages of industrialization. However, what needs a more satisfactory explanation is the subsequent continued downward trend in the male rate and the turning point and upward trend in the female one.

Participation rates vary as much by age as they do by sex. In Table 2, participation rates are presented by age and sex from 1947 to 1977. Likewise, Figure 1 illustrates the age-sex profile of labor force participation rates in 1947 and 1977. A number of important points can be established from the Puerto Rican data that are listed as follows: a.) Virtually all of the age-sex groups experienced declining labor force participation during the period of high net out-magration. b.) Female participation rates peak at an earlier age than do male participation rates. c.) The difference between male and female participation rates has been reduced over the industrialization period. d.) The most stable rates are exhibited by males 24 to 54 years of age, sometimes denoted as prime age males. e.) Significant increases in participation rates are evident in females ages 20 to 54 years. f.) And finally, for both sexes, younger and older age groups show a substantial drop in labor force participation over the period under examination.

Table 2

LABOR FORCE PARTICIPATION RATES IN PUERTO RICO BY AGE-SEX GROUPS, 1947-1972, IN FIVE YEAR PERIODS (IN PERCENT)

Age	1947	1952	1957	1962	1967	1972	1977
MALES							
16-19	66.5	54.2	47.2	43.0	38.0	33.7	25.9
20-24	81.7	90.0	74.7	84.0	81.5	76.2	69.7
25-34	89.0	92.7	86.0	92.0	93.5	91.2	87.3
35-44	95.5	96.0	95.0	93.0	91.5	89.0	86.1
45-54	94.5	94.5	90.5	91.0	89.0	84.2	77.0
55-64	84.7	83.2	83.2	83.0	79.0	70.0	58.8
65 +	55.2	53.0	45.5	36.0	31.7	27.0	19.2
FEMALE							
16-19	26.7	24.0	16.2	14.0	15.0	15.7	12.7
20-24	33.2	37.5	35.7	34.6	40.0	42.2	37.3
25-34	29.7	35.7	32.2	33.2	39.0	42.0	44.1
35-44	29.2	33.2	27.2	29.6	36.0	39.2	39.4
45-54	20.2	25.7	23.2	22.5	26.2	28.2	29.4
55-64	12.7	15.5	14.5	16.5	14.5	16.0	13.9
65 +	4.5	5.0	4.0	3.3	4.0	3.0	2.6

Source: Puerto Rico Department of Labor and Human Resources, Bureau of Labor Statistics, Household Survey, 1947-1977.

If the argument is made that males and females of similar age are substitutes for each other in the labor force, albeit imperfect substitutes, then it can be proposed that the largest degree of female-male substitution took place for workers 25 to 54 years of age. Whereas the growth of female labor force participation in the course of industrial expansion is an accepted occurrence under most circumstances, the decline in male labor force participation, especially in those groups with traditionally high labor force attachment, is more unusual.

Many of these observations require adequate explanations and it appears clear that the answers must be found in the responses of the various age-sex groups to economic and demographic forces.

Figure 1

AGE-SEX PROFILE OF LABOR FORCE PARTICIPATION RATES IN
PUERTO RICO, 1947 AND 1972
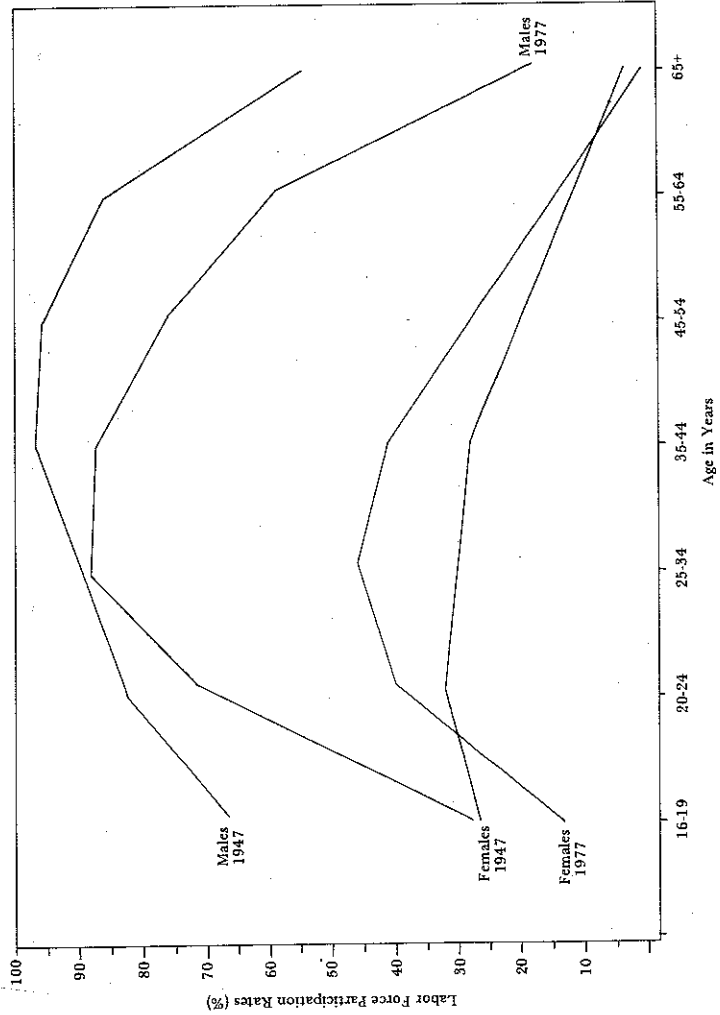
The movements in participation rates illustrate the extent to which the Puerto Rican labor force has adapted to a rapidly changing economic structure brought on by the industrialization effort. There is something to be learned from the experiences of industrialized countries in this matter, especially since the evidence regarding short-run fluctuations and long-run trends has been given more attention. Nonetheless, it should not be lost sight of that Puerto Rico is unique in many respects and still characterizes a region in transition between the developing and developed state.

II. Determinants of Short-Run Fluctuations in Labor Force Participation

At the onset it may appear unusual that the impact of cyclical changes in economic conditions is given some attention when the dominant feature of the Puerto Rican economy was its rapid and sustained growth. However, although short-run economic conditions are generally over-shadowed by longer-run growth trends, this should not imply that the short-run changes are unimportant and do not call forth adjustments in the economy. Some responsiveness of the labor force, and the various groups within the labor force, is likely to take place. This is especially true in the case of a small open economy such as Puerto Rico.

A number of hypotheses have been put forward on the manner in which the labor force might respond to changing economic conditions over the course of the business cycle. The two most well-known arguments involve the "discouraged" worker and "added" worker effects. The "discouraged" worker hypothesis consists of the view that workers will effectively drop out of the labor force as the likelihood of finding gainfull employment decreases. In addition, the overall adverse labor demand conditions keeps many workers from attempting to find employmet, and consequently, out of the labor force. Thus, the "discouraged" worker hypothesis is expected to influence the labor force attachment of workers already unemployed and workers who are currently out of the labor force. Moreover, employed workers would have little inducement to leave their current jobs, that is, alter their labor market status under the generally depressed conditions of the economy.[4]

On the other hand, the "additional" worker hypothesis sup-

ports the proposition that the size of the labor force increases during spells of prolonged unemployment. The explanation for this phenomena is usually taken in the context of the family decision-making unit. In this respect, as the primary wage earner becomes unemployed or suffers a long spell of unemployment, other family members are drawn into the labor force to bolster declining family earnings. Furthemore, family members already searching for employment will not discontinue their search activity while the depressed conditions persist.

There is little reason to expect that the "discouraged"-"additional" worker effects will be mutually exclusive. Even within identifiable labor market groups it would be sensible to expect both the "discouraged" and "additional" worker effects to operate simultaneously. Thus, what becomes important is the magnitude of the countervailing forces and their net impact. Some economists contend that during the initial downswing in economic activity the "discouraged" worker effect is dominant and reduces the labor force. But, if the probability of finding employment continues to decline or fails to improve, the "additional" worker effect predominates and the size of the labor force increases.[5]

In sum, the size of the labor force increases or decreases as workers enter or leave the labor force in response to changes in the demand for labor.[6] Moreover, it is expected that groups of workers with similar personal and labor market characteristics (such as age, sex, marital status, and labor force attachment) will respond in a similar manner on average.

---

4 It is noteworthy that the basic "discouraged" worker hypothesis stresses the decline in labor supply as workers drop out of the labor force. However, less emphasis has been placed on individuals who postpone their labor force entry or reduce quits due to declining employment opportunities. In the latter case, workers who are discouraged from quitting their current jobs would not be reflected in declining labor supply as the two previous cases would.

5 This hypothesis has been labeled the Dernburg-Strand thesis in the literature due to a study by the authors in which they attempt to empirically verify this proposition. See, Dernburg and Strand (1964), pp. 378-391.

6 The "additional" and "discouraged" worker effects are sometimes discussed in more conventional terminology as being, at least descriptively, equivalent to the income and substitution effects of unemployment on labor supply, respectively. In fact, the "net" effect of one's "own" unemployment on supply is ambiguous, a priori, and essentially an empirical question. This approach is not very satisfactory when participation rates are used to measure labor supply instead of the more conventional measure of hours worked. For a derivation of these results, see Rea (1974), pp. 279-289.

Attempts to empirically test for the existence of and estimate the magnitude of the "discouraged"-"additional" worker effects have produced almost as many differing results as there are studies. However, one result common to many of the studies is that the cyclical sensitivity of the labor force is primarily a phenomena of both youth and older adults of both sexes and women in general. Also, some, but not unanimous support has been produced to back up the claim that "additional" worker effects typify behavior of low-income groups, particularly the female labor force. In the Appendix appear some of the results of time-series labor-force participation studies dating from 1964-1977. As noted in the comments section of the Appendix, the results of the studies are quite varied. This is partly due to the empirical deficiencies observed in some of the studies as pointed out by other writers.[7]

To adequately test whether some of the hypothesized explanations for movements in labor force participation rates mentioned previously are valid, it is necessary to specify a consistent multivariate model. It is worth repeating that due to the differential behavior of the various age-sex specific groups in the population, to fully account for changes in the aggregate participation rate the determinants of participation behavior of the individual sub-groups must be investigated independently.

One of the primary hypotheses to be tested concerns cyclical variations in labor force participation rates. The responsiveness of labor force attachment to short-run economic conditions, and more so employment opportunities, has been linked to the "discouraged"-"additional" worker effects earlier. Hence, to be tested is the proposition that of all the age-sex specific groups, labor force participation of prime age males is least sensitive to fluctuations in employment conditions. Furthermore, whether the remaining groups exhibit "discouraged"-"additional" worker effects is left open for empirical examination since an *a priori* hypothesis is essentially ambiguous. In equation form, the short-run model is represented by:

7 For a review of the time series approach to labor force participation, see Jacob Mincer, "Labor-Force Participation and Unemployment -- A Review of Recent Evidence" in *Prosperity and Unemployment*, Robert A. Gordon and Margaret S. Gordon, eds. (New York, John Wiley and Sons, Inc., 1966). Mincer provides an especially strong critique of Dernberg and Strand's effort at specifying a labor force participation model.

$$L_{it} = \alpha_0 + \alpha_1 U_t + \alpha_2 T + \varepsilon_t \qquad\qquad (1)$$

where L_{it} is the age-sex specific labor force participation rate in period t; U_t is a measure of changing employment opportunities and represented by the aggregate unemployment rate in period t;[8] T is a time trend variable; and ε_t is a stochastic disturbance term. The coefficients of the equation are α_0, α_1, and α_2 and are estimated using ordinary least squares after correcting for autocorrelation using the Cochrane-Orcutt technique.[9]   Also, quarterly seasonally adjusted data are employed.

The empirical results, which appear in Table 3, give rise to three important points.   First of all, there does not appear to be a significant difference between the behavior of most male and female groups with regard to the responsiveness of their participation rates, both in magnitude and direction, to fluctuations in the aggregate unemployment rate.   Net "discouraged" and net "additional" worker effects are not in evidence for a majority of the age-sex cohorts.   This result runs contrary to the popular belief that the Puerto Rican labor force is characterized by substantial net "discouraged" worker behavior giving rise to a marked gap between potential and actual GNP.   This is not to say that a GNP gap does not exist, or that it is not growing over time, but rather, that the loss in output due to a fall in labor force participation cannot be directly attributed to net "discouraged" worker behavior on the part of the labor force.

Secondly, the only age-sex groups that do exhibit some cyclical sensitivity to changing employment opportunities are males 16-19 years of age and males 65 years and older.   The former show some net "discouraged" worker behavior while the latter exhibit net "additional" worker effects.   A one percent increase in the aggregate unemployment rate gives rise to a slightly greater than two-tenths

8 The aggregate unemployment rate was found to most reflect changing employment conditions in Puerto Rico in the short-run because it was found to be, for the most part, independent of the trend variable. The employment-population ratio was discarded because of its noticeable long-run trend (downward) which dominated shorter-run movements of the variable. Other variables that were considered, but did not perform substantially different from the aggregate unemployment rate, were lagged aggregate unemployment rates and a weighted unemployment rate, sometimes called Perry's unemployment rate.

9 Positive first-order autocorrelation was evident in the regression equations. The Cochrane-Orcutt technique was used to correct for this and, as might be expected, some coefficients that were initially statistically significant proved not to be.

Table 3

LABOR FORCE PARTICIPATION EQUATIONS FOR PUERTO RICO, 1947(I)-1978(IV) (SEASONALLY ADJUSTED)

Age	Constant	U_t	Trend	R^2	SEE	D-W	ρ
MALES							
16-19	.6403*	-.2146*	-.0029*	.95	.0242	2.29	.35*
	(.0144)	(.1073)	(.0001)				
20-24	.9017*	-.1141	-.0012*	.89	.0190	2.26	.89*
	(.0367)	(.1015)	(.0004)				
25-54	.9552*	.0137	-.0008*	.93	.0074	2.33	.93*
	(.0234)	(.0391)	(.0003)				
55-64	.9670*	-.1710	-.0026*	.94	.0221	2.08	.81*
	(.0262)	(.1198)	(.0003)				
65 +	.5682*	.1654+	-.0033*	.98	.0186	2.30	.61*
	(.0144)	(.0969)	(.0001)				
FEMALES							
16-19	.2667*	-.0780	-.0013*	.76	.0304	2.39	.63*
	(.0240)	(.1592)	(.0002)				
20-24	.3477*	-.0363	.0004*	.65	.0210	2.28	.74*
	(.0201)	(.1136)	(.0002)				
25-34	.3210*	-.1151	.0010*	.85	.0177	2.46	.79*
	(.0195)	(.0961)	(.0002)				
35-44	.2857*	-.0004	.0007*	.60	.0323	2.47	.64*
	(.0261)	(.1704)	(.0002)				
45-54	.2077*	.0742	.0005*	.66	.0180	2.23	.64*
	(.0143)	(.0945)	(.0001)				
55-64	.1626*	-.1197	.00003	.18	.0181	2.08	.38*
	(.0110)	(.0816)	(.0001)				
65 +	.0552*	.0066	-.0002*	.36	.0113	1.99	.19*
	(.0058)	(.0442)	(.00003)				

* Significant at the 1% level.
+ Significant at the 5% level.
Number of observations = 127.
Standard errors in parentheses.

of a percent decline in the labor force participation rate of males 16-19 years of age and a slightly less than two-tenths of a percent increase in the labor force participation rate of males 65 years of age and older. Since these two groups do not make up a disproportionately large percentage of the total labor force and because their net response is off-setting, the impact of short-run changes in employment conditions will have only a minimal effect on the aggregate labor force participation rate.

Thirdly, and of most importance, long-run trends are more important in determining the direction of labor force participation than short-run forces. For most male and female groups, long-run movements in labor force participation occur in opposite directions--declining in the case of the former and increasing for the latter. This phenomena has led to an apparent substitution of female for male labor within the labor force as indicated by the falling proportion of male workers in the total labor force over the course of industrial expansion. Male workers comprised 77 percent of the total labor force when the industrialization strategy was first implemented in the postwar period, and by the late 1970's this percentage fell to less than 67 percent of the total labor force.

That cyclical changes in employment opportunities do not have a substantial impact on labor force participation of most age-sex groups is not surprising since the Puerto Rican economy was undergoing rapid growth at the time. However, due to the openness of the Puerto Rican economy and its ties with the United States market, changing external economic conditions do affect the local economy. Precisely because of the island's rapid growth rate it was able to adjust quickly to adverse cyclical conditions originating beyond its borders. But, if the island's growth rate does slow down, and there is evidence that this might be taking place,[10] it would not be surprising to find an increase in the cyclical sensitivity of the labor force.

10 The downturn in economic activity brought about by the surge in oil prices in 1973-74 had a significant impact on Puerto Rico's prospects for sustained industrial expansion. The length and severity of the recession were unmatched by any previous recessionary period during the postwar era. Compounding the problem was the fact that the local government's ability to pursue countercyclical fiscal policy was substantially hampered by its precarious financial situation. For an analysis of some of the more recent problems which confront the island economy see, The Committee to Study Puerto Rico's Finances, *Report to the Governor*, (San Juan, Puerto Rico, 1975).

III. Determinants of Longer-Run Movements in Labor Force Participation

Whereas the short-run labor force participation model is seen to be primarily influenced by cyclical fluctuations in employment opportunities, the determinants of long-run trends in labor force participation are more complex. The long-run effects could result from changes in economic, demographic, and institutional forces in society which play a larger role in determining the direction and rate of labor force growth for the various age-sex specific groups than do cyclical swings in the economy. One variable given some attention in the literature as a determinant of longer-run movements in participation rates is income, of which wages or labor market earnings are a primary component. The introduction of this variable brings the discussion closer to the neoclassical tradition in emphasizing the labor-leisure choice in the participation decision.[11] Since emphasis is given to the movement of workers between the various labor force states resulting in changes in labor force participation rates, hours worked are assumed fixed for the age-sex cohorts. In this case, a change in the hourly wage is equivalent to a change in earnings, and throughout, they are taken to be synonymous. Thus, when reference is made to a substitution or income effect, kthe former refers to an increase (decrease) in labor force participation for a given increase (decrease) in wages or earnings.

The extent of migratory flows between Puerto Rico and the United States should be given primary consideration when examining the causal forces behind movements in participation rates. The magnitude of the migration stream alone, and its effects on both population and labor force, make it a prime candidate, at least during the early years of the island's industrial expansion. However, only when the migrant population exhibits greater or less labor force participation than the non-migrant population will aggregate participation rates necessarily change, *ceteris paribus*. In the case of Puerto Rico, the initial decline in participation rates during the 1950's might well be related to the net out-migration of individuals with greater than average labor force attachment. But, this always leaves open the possibility that the vacancies created by

---

11 The importance of including a wage variable in the participation equation is stressed by Jocab Mincer, "Labor Force Participation of Married Women," in Lewis (1962).

the net out-migration give impetus to increased future participation by the remaining population. Thus, the relationship between migration and labor force participation, at least in the aggregate, is not straightforward, *a priori*, and depends largely on the type of migration taking place and its determinants including social, economic, and demographic variables.

The migratory process is a selective one, and hence, certain age-sex specific participation rates will move in response to migration more than others. A similar phenomena occurs with the effects of additional independent variables. For example, youths of both sexes will generally alter their labor force attachment given expanding educational opportunities. Other variables having an effect on the timing of participation, and hence, on aggregate labor force participation rates, include: a.) fertility of females of childbearing age, b.) social security payments of the population of retirement age, and finally, c.) the existence of transfer payments, of various types, which have steadily increased in Puerto Rico over the years. The list could easily be expanded but knowledge of the workings of the Puerto Rican economy indicate that these are the ones with the greatest likelihood of influence.

Permanent Wage and Relative Income Models of Labor Force Participation

It is well-known that the effect of wage rates on labor supply is ambiguous *a priori* and depends on the relative strengths of income and substitution effects. The substitution effect of a wage change has a positive impact on labor supply as, in the case of rising wages, the opportunity cost of leisure relative to working activities increases. On the other hand, the income effect provides a negative influence on labor supply, hence, a rise in wages causes a move toward more leisure and less work. However, in the case of labor force participation, where the crucial decision is whether to enter or leave the labor force and not so much whether more or less hours are worked, a qualification must be added. The income effect of a wage change serves to reduce hours worked, but in the labor force participation model there is no way that a wge increase could reduce hours worked to zero, which would be equivalent to an employed worker dropping out of the labor force.[12] Thus, a

---

12 See the comment by Ben-Porath (1974), pp. 697-704.

more acceptable way to interpret the income effect is that, in combination with other variables such as non-labor income, it increases an individual's reservation wage relative to the current wage bringing about a reduction in labor force participation.

Underlying the wage variables are two competing views on the effect that they might have on labor force participation over time. The first hypothesis is based on the permanent wage model developed by Lucas and Rapping,[13] while the second has more recently been identified with the work of Wachter and responds to the relative income model.[14] The former involves the relation between the current market wage (W) and the permanent real wage (W*) which can be thought of as an anticipated or expected wage level determined, for all practical purposes, by the level of real wages previously attained. On the other hand, in the relative income model a comparison is made between current earnings (call it W also) and a desired standard of living (W').

The permanent wage model holds that workers will time their entry into the labor force to coincide with periods where the transitory wage is high relative to their permanent wage. Likewise, it would be rational to postpone labor force entry when wages are low compared to one's permanent wage level. This is consistent with the goal of maximizing income throughout one's lifetime.

On the other hand, the relative income theory supports the view that individuals, and more so households, desire to mainain a certain standard of living throughout their lifetimes. This relative standard of living, represented by W/W' is determined not only by one's earnings (W), but also by the level of current income of other age-sex groups (W'). Specially then, when W decreases relative to W', workers perceive a drop in family income compared to other age-sex groups and hence proceed to join or rejoin the labor force in an effort to maintain the desired level of income. However, when W is high or increasing relative to W', the theory predicts a reduction in labor force participation. It goes without saying that this effect is supposedly strongest among married females. If this is so, it should be mentioned that the participation decision should have a significant impact on fertility rates. Likewise, rising or fall-

13 See, Phelps (1970).

14 Wachter (1972), p. 143, gives credit to J. S. Duesenberry (1949) and Easterlin (1968) for the initial formulation of the relative income model.

ing fertility rates will have an impact on the age structure of the labor force in later years.[15]

The impact of both permanent and relative income effects on labor force participation are explicitly considered by Wachter (1972, 1977) and the alternative hypotheses tested for the secondary labor force. Although Wachter's theoretical approach appears to be correct, the empirical formulation of it is not an appropriate one for the secondary labor force and, in fact, is better suited for the primary labor force (males 25-54 years of age).

Figure 2 illustrates the permanent wage effect on labor force participation. Assuming a supply function of the form:

$$S = S(W^*) \qquad\qquad (2)$$

where W^* is the permanent wage and the slope of the supply curve is indeterminate *a priori* due to the off-setting substitution and income effects of a change in the permanent wage. If the substitution effect outweighs the income effect, the supply function might appear as it does in Figure 2. According to the permanent wage model, there exists a corresponding transitory supply function given by:

$$S = S(W/W^*) \qquad\qquad (3)$$

where W is the current transitory wage. Supply functions (2) and (3) intersect at the point where $W = W^*$. However, if the transitory wage rises for a given W^*, the participation rate, or labor supply moves up to point A. On the other hand, since W^* reflects past and current values of W, W^* will eventually rise to the point where it is again equal to W and participation rates will settle at the level corresponding to point B. A new transitory wage func-

---

15 It is noteworthy that changes in relative income for different groups have been linked to demographic forces. In fact, Wachter (1977) found that the relative income of both females and males who were just entering the labor force, or very young, was steadily declining and that this phenomena could be explained by intermediate swings in demographic variables. For example, the large number of young workers coming into working age in the late 1960's in the United States were instrumental in putting downward pressure on the wages they could obtain relative to wages of other groups. Thus, the fall in relative income served to explain some of the increases in labor force participation experienced by the younger workers. It was also found that this has resulted in noticeable decreases in fertility rates. In sum, Wachter repeated, and put to a test, an important point which Mincer suggested in his very important 1966 article; demographic shifts of the population, over time, are a prime determinant of labor force behavior, and perhaps, even more significant than short-run fluctuations in employment opportunities.

Figure 2

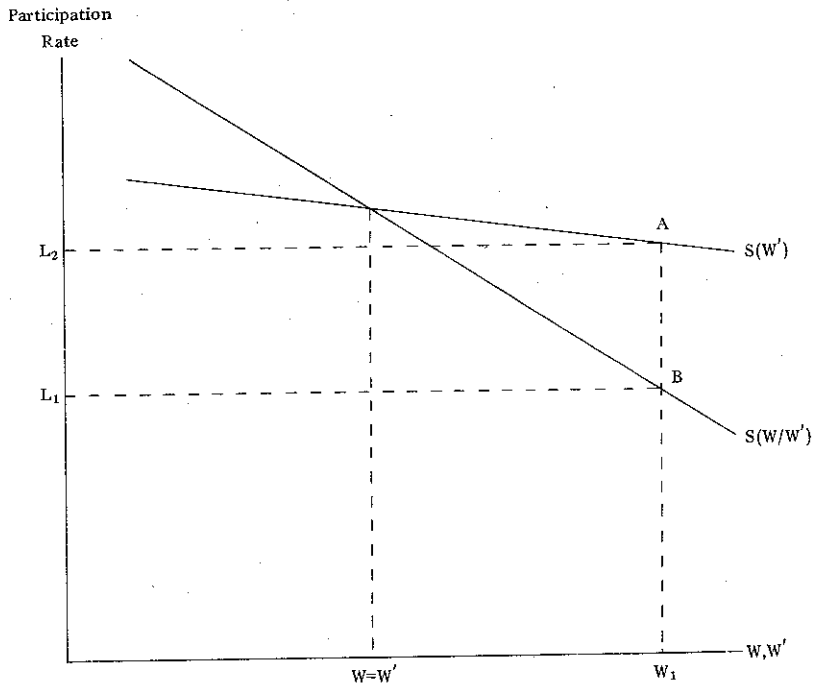### THE PERMANENT WAGE MODEL OF LABOR FORCE PARTICIPATION
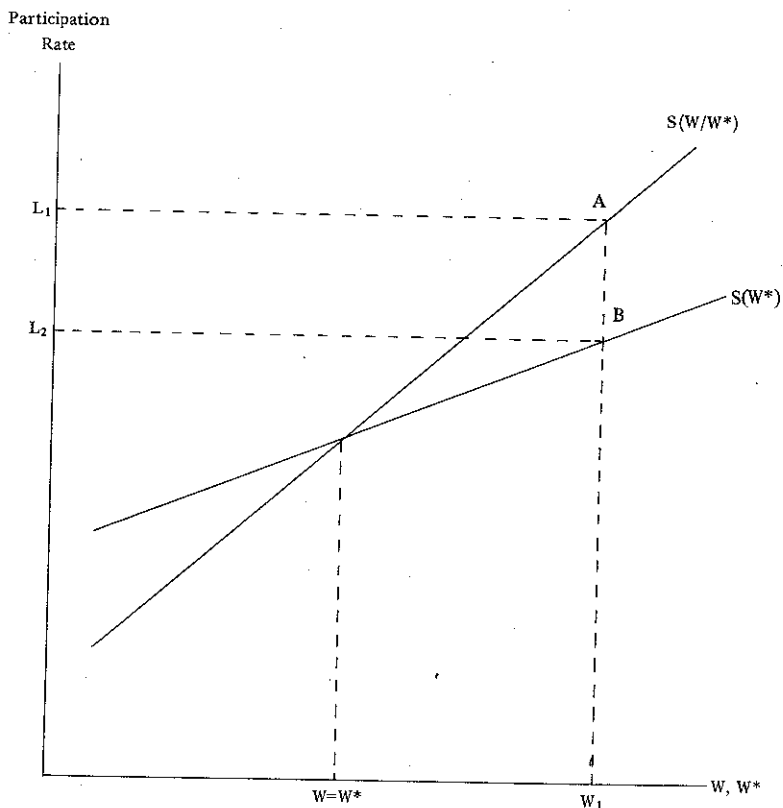
tion will then cross the permanent wage supply function at the new point B and the process will repeat itself. In effect, then, the primary characteristic of the permanent wage model is that a change in W/W^* reinforces the substitution effect of a wage change.

On the other hand, the relative income model, illustrated in Figure 3, has the opposite effect on labor force participation. That is, it strengthens the income effect of a given wage change. If the various age-sex cohorts view a given wage, W', as representing a standard of living they would like to keep pace with, the supply function, $S = S(W')$, might appear as that in Figure 3 (again,

substitution and income effects give rise to an indeterminate slope a priori). Comparing their current wage to the standard, (W/W'), produces a supply function of the form $S = S(W/W')$. An increase in the current wage relative to the standard produces a fall in the participation rate, while a fall in (W/W') results in an increase in labor force participation. For example, a rise in (W/W') results in a downward movement to B initially and then over time (when $W = W'$) the participation rate will tend to A (see Figure 3).

Figure 3

THE RELATIVE INCOME MODEL OF LABOR FORCE PARTICIPATION

The impact of permanent wage and relative income models on labor force participation is to produce off-setting effects, and hence, the final outcome is dependent upon the relative strengths of both. Wachter attempts to capture the net effect and in that manner determine which model has the most influence on labor force participation. To do this, he makes the simplifying assump-

tion that $W^* = W'$. In other words, the cohort's permanent wage is identical to the earnings standard that they would like to achieve. If this were the case ($W^* = W'$), one need only compare the functions $S(W^*)$ with $S(W/W^*)$ to determine the net impact of permanent wage and relative income effects. The slope of $S(W^*)$ for males is given by β_1, and the slope of $S(W/W^*)$ for males is β_2. Thus, if $\beta_1 > \beta_2 (\beta_2 > \beta_1)$, the net impact of a change in earnings points to a stronger relative income (permanent) wage effect than a permanent wage (relative income) effect.

The regression equation for the male labor force is given by:

$$L^m_j = \beta_0 + \beta_1 (W^*_m) + \beta_2 (W^m / W^*_m) + \beta_3 (U)$$

$$+ \beta_4 (M) + \beta_5 (S) + \varepsilon_j \qquad (4)$$

where L^m_j is the labor force participation rate for male workers in age group j; W^*_m is the permanent real wage for male workers;[16] (W^m/W^*_m) is the ratio of the current real wage of male workers to their permanent real wage; (M) is the net migration rate (net migration divided by total population); (S) is the ratio of public sector transfer payments to net income;[17] and ε_j is a stochastic disturbance term for each age group. The signs on coefficients β_1, β_2, β_3, and β_4 are indeterminate, a priori, while β_5 is expected to be negative. It is anticipated that (β_2-β_1) will be positive, thus giving evidence of a permanent wage effect.

The equality of W^* and W' is a strong assumption to make and is most valid for males. However, for the female labor force it is unlikely that their permanent wage will be identical to the wage standard they would like to achieve. It would be more realistic to assume that the latter view the wage accorded the male labor force

16 The permanent real wage is taken to be a function of current and past real wges. To estimate W^* for both males and females a non-stochastic distributed lag model with exponentially declining weights over a twelve-quarter period was used. The wage variable employed was that of real average weekly earnings for both male and female labor force groups.

17 Both net migration and transfer payment figures are available only on an annual basis. Thus, quarterly estimates were obtained based on interpolation of the yearly series. Net migration is calculated from a survey of net passenger movement while transfers include both federal and local government transfer payments as defined in Puerto Rico's national income accounts.

as the desired level. Thus, in estimating the net effect of permanent wage and relative income models on the labor force participation of females, an approach that differs from that used for the male labor force is needed.

Ideally, the estimation process for the female labor force would involve a comparison of α_1 (slope of $S(W^*)$ for females) to α_2 (slope of $S(W/W^*)$ for females) on the one hand; and on the other, a comparison of α'_1 (slope of $S(W')$) to α'_2 (slope of $S(W/W')$). Furthermore, the net effect of permanent wage and relative income effects is given by the difference between $(\alpha_2-\alpha_1)$ and $(\alpha'_1-\alpha'_2)$ if $\alpha_2 > \alpha_1$ and $\alpha'_1 > \alpha'_2$. The possible outcomes are summarized in Table 4. The information in Tabel 4 indicates that only cases 2 and 3 are relevant if the assumption is made that $W^* = W'$, which implies that $\alpha_1 = \alpha'_1$ and $\alpha_2 = \alpha'_2$.

Table 4

POSSIBLE OUTCOMES OF PARAMETERS OF THE PERMANENT
WAGE AND RELATIVE INCOME MODELS

Case	Outcome		Conclusion
I	$\alpha_2 > \alpha_1$	$\alpha'_1 > \alpha'_2$	net effect depends on relative magnitudes
II	$\alpha_2 > \alpha_1$	$\alpha'_2 > \alpha'_1$	supports permanent wage model
III	$\alpha_1 > \alpha_2$	$\alpha'_1 > \alpha'_2$	supports relative income model
IV	$\alpha_1 > \alpha_2$	$\alpha'_2 > \alpha'_1$	neither model holds

For the female labor force, the regression equation would take the form:

$$L^f_j = \alpha_0 + \alpha_1 (W^*_f) + \alpha_2 (W^f / W^*_f)$$

$$+ \alpha'_1 (W') + \alpha'_2 (W^f / W') + \alpha_3 (U) + \alpha_4 (M) + \alpha_5 (S) + \gamma_j \qquad (5)$$

where L_j^f is the labor force participation rate of females of age group j; W' is a measure of the earnings standard desired by females; (W^f/W') is the ratio of their current real wage to W'; W_f^* is the permanent real wage facing female workers; and (W^f/W^*) is the ratio of their current real wage to their permanent real wage. The remaining variables are described as in Equation (4) with γ_j the disturbance term for the female age groups. Again, the signs of parameters α_1, α_2, α_3, α_4, α'_1, and α'_2 are indeterminate, while α_5 is hypothesized to be negative.

Originally, estimation of Equation (5) included W_m^* as a proxy for W'. This implies that females view the male permanent wage as the desired standard. However, due to the extreme collinearity between W_m^* and W_f^*, the parameter estimates were found to be quite unreliable. On the other hand, the collinearity between W_m^* and W_f^* signifies that W_f^* may be introduced as a proxy for W' making the determinants of labor force participation for female workers identical to those of Equation (4) except for the substitution of W_f^* for W_m^* and W_f for W_m. Thus, only outcomes 2 and 3 in Table 4 are relevant.

Results of the Long-Run Labor Force Participation Model

The empirical results appear in Table 5 for males and females of various age groups. The data consists of quarterly observations from 1947 to 1978 and are adjusted to account for seasonal effects. Originally, ordinary least squares method was applied to obtain the parameter estimates. However, the existence of positive first-order autocorrelation, so prevalent in aggregate time-series models of this sort, made the preliminary estimates unreliable leading one not to reject null hypotheses when should be. The Cochrane-Orcutt technique was used to correct for this and the estimates were derived using ordinary least squares.

Ths first observation is that the various labor force groups continue to show little sensitivity to changing employment opportunities as represented by the aggregate unemployment rate. Only males 16-19 years of age exhibit net "discouraged" worker behavior. This was evident in the short-run model as well. On the other hand, males 65 years of age and older, which showed a net "additional" worker response in the short-run model, do not give evidence of significant cyclical variations in the long-run model. As one might expect, rapid industrialization tends to reduce the im-

LABOR FORCE PARTICIPATION RATE EQUATIONS FOR PUERTO RICO, 1947(I)-1978(IV)

Age	16-19	20-24	25-54	55-64	65+
MALES					
Constant	.7940*	.8933*	.9436*	.9010*	.6535*
	(.0462)	(.0435)	(.0123)	(.0389)	(.0403)
(W_m^*)	-.0061*	-.0006	-.0003	-.0027*	-.0054*
	(.0006)	(.0009)	(.0002)	(.0003)	(.0008)
(w^m/W_m^*)	-3.7097	-.2773	.6594	8.7232*	-4.0711+
	(3.5300)	(1.9220)	(.7981)	(3.08)	(2.1357)
(U)	-.4100*	-.0580	.0324	-.2002	.0667
	(.1581)	(.1072)	(.0405)	(.1205)	(.1155)
(M)	-.0005*	-.0002	.00003	.00004	.0003*
	(.0002)	(.0001)	(.00004)	(.0001)	(.0001)
(S)	-.0031*	-.0049*	-.0036*	-.0082*	-.0047*
	(.0015)	(.0018)	(.0005)	(.0009)	(.0017)
R^2	.94	.89	.94	.95	.97
SEE	.0269	.0190	.0070	.0207	.0203
D-W	2.37	2.17	2.22	1.61	2.43
ρ	.68*	.87*	.78*	.49*	.84*

Age	16-19	20-24	25-34	35-44	45-54	55-64	65+
FEMALES							
Constant	.3495*	.3537*	.3142*	.2876*	.1649*	.1639*	.0339+
	(.0560)	(.0377)	(.0317)	(.0646)	(.0348)	(.0333)	(.0198)
(W^*_f)	-.0033*	.0001+	.0016*	.0010	.0008*	.0005*	-.0002+
	(.0006)	(.0005)	(.0006)	(.0006)	(.0004)	(.0002)	(.0001)
(W^f/W^*_f)	-2.9615	-.3865	.0029	.0217	4.0727	-1.9257	1.4515
	(4.5733)	(2.9762)	(2.2690)	(5.3313)	(2.8525)	(2.4879)	(1.4309)
(U)	-.0891	.0659	-.1118	.0080	.0741	.0669	.0749
	(.1733)	(.1221)	(.1034)	(.1922)	(.1065)	(.0995)	(.0631)
(M)	-.0007*	-.0002+	-.00001	-.0002	-.00006	.000003	.000002
	(.0002)	(.0001)	(.0001)	(.0002)	(.0001)	(.00009)	(.00005)
(S)	-.0013	-.0015	.0015	.0015	.0009	-.0019*	-.0009*
	(.0016)	(.0013)	(.0013)	(.0017)	(.0010)	(.0006)	(.0004)
$\bar{R}^2$	.78	.66	.85	.60	.66	.26	.37
SEE	.0295	.0209	.0180	.0325	.0181	.0174	.0114
D-W	2.26	2.25	2.44	2.45	2.28	2.03	2.00
ρ	.67*	.73*	.79*	.64*	.67*	.27*	.19*

* Significant at the 1% level.
+ Significant at the 5% level.
Number of observations = 127.
Standard errors in parentheses.

pact of changing employment opportunities in the short-run on the participation of demographic groups in the labor force.

A comparison of permanent wage and relative income effects appears in Table 6. A positive coefficient in column 3 indicates a predominant permanent wage effect, while a negative value points to a stronger relative income effect. The labor force participation behavior of all male groups and very young and older females is in accord with that expected of the permanent wage model. In contrast, the relative income model is more representative of the behavior of the remaining female groups.[18] This confirms Wachter's earlier finding that the relative income model is more likely to describe the behavior of the so-called secondary labor force, of which females are the primary component.

Table 6

WAGE ELASTICITIES OF SUPPLY

MALES	(1) (W_m^*)	(2) (W^m/W_m^*)	(2)-(1)
16-19	-0.52	-0.090	0.43
20-24	-0.07	-0.004	0.07
25-54	-0.01	0.008	0.02
55-64	-0.13	0.119	0.25
65+	-0.54	-0.115	0.42
FEMALES	(1) (W_f^*)	(2) (W^f/W_f^*)	(2)-(1)
16-19	-0.64	-0.182	0.46
20-24	0.01	-0.011	-0.02
25-34	0.14	0.000	-0.14
35-44	0.10	0.000	-0.10
45-54	0.10	0.173	0.07
55-64	0.11	-0.136	-0.25
65+	-0.16	0.385	0.54

Note: Elasticities evaluated at the means.

18 Census information indicates that income of females as a percentage of income of prime age males declined during the decade of the 1950's and increased somewhat during the 1960's. Thus, the decline in relative income of female workers that Wachter observed for the U.S. appears not to be as strong in Puerto Rico.

The increased labor force participation of females 20 to 64 years of age is partly the result of increases in female permanent earnings. For all five of these age groups, the coefficient on (W_f) is positive and significantly so in four out of five cases. The increase in female earnings can be traced to rising labor demand in tertiary sector activities, of which public sector employment is a primary component with female workers providing a good part of the hired labor force. On the other hand, both females 16-19 and 65 years of age and older, which show declining labor force participation during the course of industrial expansion, indicate an inverse relation between participation and the trend in permanent female earnings.

The decline in male labor force participation has occurred while male permanent earnings have increased. In the conventional hours worked labor supply model this would provide evidence of a relatively stronger income effect. But, in the labor force participation model an increase in permanent earnings which, in conjunction with other income, succeeds in raising the reservation wage of this group, results in declining labor force participation. However, for male workers between the ages of 20 and 54 (includes prime-age male workers) no statistically significant relation could be found between labor force participation and male permanent earnings. Only for teenage males and workers over 54 years of age was the income effect in the labor force participation model prevalent.

The evidence indicates that the decline in male participation can be linked to increases in social expenditures in the form of transfer payments. For all male groups (and females over the age of 54), the coefficient on (S) was negative. The growth of social expenditures has proceeded rapidly and hand-in-hand with industrial expansion. Most of these payments are linked to past labor force attachment, and hence, their effect is felt primarily by male groups rather than females. The apparent impact of these expenditures on male participation has been to delay entry into the labor force and accelerate exits by means such as early retirement.

Net out-migration has declined during the period of rapid industrialization--reaching its peak during the 1950's, declining during the 1960's, and reverting to net in-migration during the 1970's. The empirical results suggest that movements of labor force participation rates for most groups (but not all) are un-

affected by migratory flows between Puerto Rico and the United States which runs contrary to *a priori* expectations and casual observation. The reason for this may be linked to three sources: 1.) the labor force attachment of the migrant population differed little from that of the population in general; 2.) the migration variable has been measured with error; and/or 3.) a non-linear relation exists between the net migration rate and the age-sex specific participation rates. Of the three, the last appears to be a more plausible explanation for the unexpected results.

To confirm this, parameter estimates were obtained over two non-overlapping periods of time. The first during the period of net out-migration (1947-1968), and the second (1972-1977) over the period of net in-migration only. It is noteworthy that the results of this exercise improved earlier ones only slightly. The indication is that for males and females ages 55-64 years, net out-migration was partly responsible for the reduction in their participation rates indicating greater labor force attachment of migrants relative to the total population of this group. On the other hand, participation rates of both males and females 16-24 years of age declined as a result of net in-migration since, apparently, the migrants of this age group exhibit less labor force attachment than their population in general. The opposite was found for both males and females 65 years and older for which participation rates during the period of net in-migration were positively associated with the migratory movement.

IV. Conclusion

Knowledge of both the rate of growth and direction of change of the labor force is important for development planners and economic policy-makers alike. To fully understand the determinants of movements in aggregate labor force participation it is, necessary to decompose the aggregate rate into its components by age and sex. One thing that this study has indicated is that the various demographic groups exhibit differential behavior to relatively similar economic forces. The responsiveness of the various age-sex groups is largely determined by their position in the life cycle.

The cyclical sensitivity of the labor force is over-shadowed by

longer-run forces determined, for the most part, by the process of industrialization in Puerto Rico. Short-run losses in output due to "discouraged" worker behavior do not appear to be substantial in the face of rapid economic growth. However, as financial constraints on the public sector make it more difficult to promote continued industrial expansion in the face of external disturbances, the cyclical sensitivity of the labor force is bound to increase.

Longer-run trends are more important in determining movements in labor force participation in Puerto Rico than are cyclical forces. The apparent decrease in male participation and increase in female participation has, to a certain extent, brought about a substitution of female for male labor. This can be partly attributed to a narrowing of the differential in labor market earnings between the two groups and the increase in non-labor income of males. The growth of trade and service activities coupled with the expansion of public sector employment resulted in increased demand for clerical, sales, and other service personnel which sharply expanded the possibilities of female employment. Furthermore, changes in fertility rates, family size, educational opportunities and attitudes toward female labor brought about an environment which stimulated increases in female labor force participation.

Emphasis has been placed on the movement of participation rates within identifiable age-sex groups. However, it is also important to realize that underlying the movements in the aggregate rates are changes at the micro-economic level. Of particular interest is the participation decision within the household setting. Family workers do not make their participation decisions independently of that of other family members. It would be useful to test some of the hypotheses presented in this paper at the micro level and to inquire whether the substitution of female for male labor, which is evident in the economy as a whole, reflects a process of substitution that is operating within individual household units.

References

Barth, Peter S., "Unemployment and Labor Force Participation," *Southern Economic Journal,* Vol. 34, January, 1968, pp. 375-382.

Ben-Porath, Yoram, "Labor Force Participation Rates and the Supply of Labor," *Journal of Political Economy,* Vol. 82, August, 1974, pp. 679-704.

Committee to Study Puerto Rico's Finances, *Report to the Governor* (San Juan, Puerto Rico, 1975).

Dernburg, Thomas and Kenneth Strand, "Cyclical Variation in Civilian Labor Force Participation," *Review of Economics and Statistics,* Vol. 46, November, 1964, pp. 378-391.

_____, "Hidden Unemployment 1953-62: A Quantitative Analysis by Age and Sex," *The American Economic Review,* Vol. 56, March, 1966, pp. 71-95.

Duesenberry, J. S., *Income, Saving, and the Theory of Consumer Behavior* (Cambridge, Harvard University Press, 1949).

Durand, John D., *The Labor Force in Economic Development* (Princeton, Princeton University Press, 1975).

Easterlin, Richard A., *Population, Labor Force, and Long Swings in Economic Growth: The American Experience* (New York, Columbia University Press for the National Bureau of Economic Research, 1968).

Fair, Ray C., "Labor Force Participation, Wage Rates, and Money Ilusion," *Review of Economics and Statistics,* Vol. 53, May, 1971, 164-168.

Gordon, Robert A. and M. S. Gordon, *Prosperity and Unemployment* (New York, John Wiley and Sons, Inc., 1966).

Lewis, H. Gregg, *Aspects of Labor Economics* (Princeton, Princeton University Press, 1962).

Officer, Lawrence A. and P. R. Anderson, "Labor Force Partici-pation in Canada," *The Canadian Journal of Economics,* Vol. 2, May, 1969, pp. 278-287.

Phelps, Edmund S., *Microeconomic Foundations of Employment and Inflation Theory* (New York, W.W. Norton and Co., 1970).

Rea, Samuel A., "Unemployment and the Supply of Labor," *Journal of Human Resources,* Vol. 9, Spring, 1974, pp. 279-289.

Standing, Guy, *Labour Force Participation and Economic Development* (Geneva, International Labour Office, 1978).

Standing, Guy and Glen Sheehan, *Labour Force Participation in Low-Income countries* (Geneva, International Labour Office, 1978).

Tella, Alfred, "The Relation of Labor Force to Employment," *Industrial and Labor Relations Review,* Vol. 18, April, 1964, pp. 454-469.

————, "Labor Force Sensitivity to Employment by Age, Sex," *Industrial Relation,* Vol. 4, February, 1965.

Wachter, Michael L., "A Labor Supply Model for Secondary Workers," *The Review of Economics and Statistics,* Vol. 54, May, 1972, pp. 141-151.

————, "Intermediate Swings in Labor-Force Participation," *Brookings Papers on Economic Activity,* No. 2, 1977, pp. 545-574.

Appendix

SUMMARIES OF STUDIES DESIGNED TO TEST FOR "DISCOURAGED"-"ADDITIONAL" WORKER BEHAVIOR

Study	Primary Explanatory Variance	Model Specification	Comments and General Results
Tella (1964)	$(E_i/P_i)_t$	$(L_iP_i)_t = f\left((E_i/P_i)_t, T\right)$	The regression model was estimated using annual data from 1948-1962 in both first difference and current period form. The female labor force was found to be more responsive to labor demand conditions than the male labor force. Some evidence of net "discouraged" worker behavior for both sex groups, but much more so for females.
Dernburg and Strand (1964)	$(E/P)_t, (X/P)_{t+2}$	$(L/P)_t = f\left\{(E/P)_t, (X/P)_t, (X/P)_{t+2}, (1/P)_t\right\}$ $(X/P)_t = g\left\{(E/P)_{t-1}, (X/P)_{t-1}\right\}$	A two-equation system was estimated using monthly data from 1953-1962. Dummy variables were introduced to account for seasonal variations and are reflected in the intercept term which differs with the month of the year. The results give evidence for both the "discouraged" and "additional" worker effects. However, the "discouraged" worker effect was found to dominate during early phases of a downturn with "additional" worker behavior becoming predominant as the recessionary conditions continued.

Study	Primary Explanatory Variance	Model Specification	Comments and General Results
Tella (1965)	$(E_{ij}/P_{ij})_{t-1}$	$(L_{ij}/P_{ij})_t = f \left\{ (E_{ij}/P_{ij})_{t-1}, \log T \right\}$	Estimation was based on seasonally adjusted quarterly data from 1947-1964. All age-sex groups exhibited a net "discouraged" worker effect to some extent, although it was most pronounced for both young and older males and all female groups.
Demburg and Strand (1966)	$(E/P)_t, (X/P)_{t-2}$	$(L_{ij}/P)_t = f \left\{ (E/P)_t, (X/P)_{t+2}, \right.$ $(I/P)_t, (P_{ij}/P) \}$ $(X/P)_t = g \left\{ (E/P)_{t-1}, (X/P)_{t-1} \right\}$ $(E_{ij}/P) = h \left\{ (E/P)_t, (I/P)_t, (P_{ij}/P)_t \right\}$	The data base underlying the system of equations was monthly and covered the period 1952-1962. As in the previous article, dummy variables were included to account for seasonal changes in the primary explanatory variables for males 25-65 years of age. Nonetheless, both "discouraged" and "additional" worker effects were in evidence for all female and young and older male groups.
Barch (1968)	$(U/L)_{t-1}, (X/U)_{t+1}$	$(L_{ij}/P_{ij})_t = f \left\{ (U/L)_{t-1}, \right.$ $(X/U)_{t+1}, T \}$	The regression model was specified using quarterly data by age-sex groups from 1948-1964. Quarterly dummy variables were inserted into the model to account for seasonality. A Koyck lag formulation was also attempted but with no significant improvement in results. Contrary to earlier findings there was no evidence for "discouraged" or "additional" worker behavior on the part of most female groups. However, surprisingly, a small "discouraged" worker effect was evident in some male groups.

Study	Primary Explanatory Variance	Model Specification	Comments and General Results
			groups. The study showed little support for the Dernburg-Strand thesis.
Officer and Anderson (1969)	$(U_m/L_m)_t$, $(S^p_m/U_m)_t$, $(S^p_m/L_m)_t$ $P = 0,1,3,6$	$(L_{ij}/P_{ij})_t = f \left((U_m/L_m)_t, (S^p_m/U_m)_t, (S^p_m/L_m)_t, y_t, (W/Pr)_t, C_t, B_{t+1} \right)$	The regression coefficients were estimated using Canadian data from 1950-1967 (quarterly). The explanatory variables used to test for evidence of "discouraged" or "additional" worker behavior represent increasingly intensive measures of unemployment duration. The "discouraged" worker effect was found to dominate in the male age groups while "additional" worker behavior was evident for female groups. Furthermore, both male and female teenage groups exhibited some "discouraged" worker behavior.
Fair (1971)	$(E/P)_t$	$(L_{ij}/P_{ij})_t = f \left((E/P)_t, W_{t-x}, Pr_{t-x}, T \right)$	Quarterly seasonally adjusted data was employed from 1956-1970. Estimation followed the Cochrane-Orcutt technique within the context of the Almon distributed lag procedure. Although the author emphasized the impact of the wage and price terms, net "discouraged" "additional" worker hypotheses were also tested for. The employment rate was found to be positively and significantly related to labor force participation rates for most female groups and younger older males. Thus, a net "discouraged" worker effect was evident.

Study	Primary Explanatory Variance	Model Specification	Comments and General Results
Wachter (1972)	$(U/L)_t$, U_{dummy}	$(L_{ij}/P_{ij})_t = f\{(U/L)_t, U_{dummy}, W^*, W_t/W^*, Pr_t/Pr^*\}$	The model was applied to the secondary labor force (all female groups and males 16-19 and 65 years of age and older) for the quarterly periods from 1948-1968. The Cagen lag techique was used to estimate the lags on the starred terms and the unemployment rate. General results indicated weak support for the "discouraged"·"additional" worker model. Only during periods of extremely high unemployment, as measured by the U_{dummy} term, was there found to be a significant net "discouraged" worker effect. On the other hand, some "additional" worker behavior was evident for females 45 yrs. and older.
Wachter (1977)	$(U_{Perry})_t$	$(L_{ij}/P_{ij})_t = f\{(U_{perry})_t, (RP_t), (L_{ij}/P_{ij})_{t-1}, T, W_t/W^*\}$	All equations were estimated with annual data for the period 1949-1976. "Discouraged" worker effects were found to be strongest for male and female teenagers. Only slight "discouraged" worker effects were found in adults over 24 years of age and virtually none for adult females. When additional variables were included to capture determinants of longer term trends in participation rates, the "discouraged" worker model fared even worse.

Identification of Symbols

E	= total employment
P	= total non-institutional population.
U	= total unemployment.
i	= sex.
j	= age.
t	= time.
T	= time-trend variable.
X	= "exhaustions rate."
U_m	= unemployed males.
L_m	= male labor force.
S_m^0	= males seeking work, excludes males on temporary lay-off.
S_m^1	= males seeking work over one month.
S_m^3	= males seeking work over three months.
S_m^6	= males seeking work over six months.
Y	= real per capita income.
W	= nominal wage rate.
Pr	= price index.
C	= change in outstanding consumer credit deflated by wage rate.
B	= birth rate.
U_{dummy}	= dummy variable which takes the value of the unemployment rate between 1958 and 1966 and zero elsewhere.
W^*	= permanent wage rate.
Pr^*	= perceived price level.
U_{perry}	= weighted unemployment rate, weights consist of earnings of different age-sex groups.
RP	= age structure of the civilian population; population aged 16-34 divided by the total civilian non-institutional population.