

MODERNIZATION AND FERTILITY IN PUERTO RICO:  
A RE-EXAMINATION\*

*Shu-O W. Yang\*\**  
*Kent State University*  
*Kent, Ohio 44242*

ABSTRACT

This paper re-examines the relationship between modernization and fertility based on the 1970 Puerto Rican census data. A comparison of the findings with a previous study of 1950 and 1960 Puerto Rico census is presented. For a society in the midst of economic development such as Puerto Rico, it is proposed that community's fertility rate is a function of both the general level and timing of societal development. The paper lays its special emphasis on this. The findings indicate that education and industrialization have increased their direct negative influences on fertility from 1950 to 1970 while income and proportion of women working have decreased theirs. Urbanization has lost its direct influence on fertility since 1960 and is distributing its effect indirectly through other variables.

The inverse relationship between modernization (i.e., urbanization and industrialization) and fertility has been explained by the demographic transition theory. According to this theory, the fertility level of a society starts declining due to the progress in socio-economic development in the process of urbanization and industrialization. However, it has been suggested that modernization in itself does not have any miracle to influence fertility level: the influence is indirect rather than direct. In other words, modernization and the declining of fertility is linked indirectly to each other by a set of intervening variables such as educational development, income, proportion of women working, and so on.

The study of 41 nations by Heer (1966:444) suggested that economic development, if it is to be effective in reducing fertility, must be accompanied by changes in social structure—changes that in some degree usually accompany industrialization. The observations of a study by the United Nations (1965:145) pointed out that the association of urbanization and industrialization with fertility are indirect. A study of fifteen nations by

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\*\*Assistant Professor, Kent State University

Kasarda (1971) showed how modernization effects fertility through the intervening economic-structure variables. Also a study of fifty-two countries by Bali Ram (1972) confirmed that urbanization and industrialization affect fertility through the postulated three intervening variables: education, female labor force participation rate, and infant mortality rate. A recent study of the relationship between modernization and fertility in Puerto Rico by Rico-Velasco and Schwirian (1972) based on 1950 and 1960 census data suggested that urbanization and industrialization are viewed as having a positive impact upon education, income and women working, and a negative effect upon fertility. Furthermore, education and income are viewed as having a direct effect on women working, and negative on fertility. Finally, women working is viewed as causing a negative effect on fertility.

This paper attempts to re-examine the relationship between modernization and fertility based on the 1970 Puerto Rican census data, using basically the same approach as used by Rico-Velasco and Schwirian (1972). A comparison of the findings of 1970 with that of 1960 and 1950 will be presented. For a society in the midst of economic development such as Puerto Rico, it is proposed that community's fertility rate is a function of both the general level and timing of societal development. This paper will lay special emphasis on this.

#### STATEMENT OF HYPOTHESES

From the results of previous fertility studies, especially the study of 1950 and 1960 Puerto Rican census data by Rico-Velasco and Schwirian (1972), the causal linkages between modernization and fertility are hypothesized as follows:

1. Degree of urbanization/industrialization, educational level, economic status (income), and the proportion of women working of a community have negative effects directly upon the community's fertility level.
2. Urbanization, industrialization, education and income have positive effects on the proportion of women working directly.
3. Urbanization, industrialization and education have positive direct effects upon the income of the population.
4. Urbanization and industrialization have positive influence directly upon educational level of the community.
5. Urbanization and industrialization are associated with each other but there is no causal priority between them.

## TEST OF HYPOTHESES

Census data of Puerto Rico, 1970, are used to demonstrate the relationship between modernization and fertility. Data on six sociodemographic variables were taken from 75 Puerto Rican *Municipios* (areal units roughly equivalent to counties in the United States). The dependent variable is the fertility ratio and the independent variables are urbanization, industrialization, income, education, and proportion of women in the labor force. These variables are interpreted by operational definitions as follows:

*Fertility Ratio*: Children ever born per 1,000 women ever married.

*Urbanization*: percent population urban (living in places of 2,500 population and over).

*Industrialization*: percent employed persons in manufacturing.

*Income*: Median income in dollars of the community.

*Education*: Median school years completed by adult population.

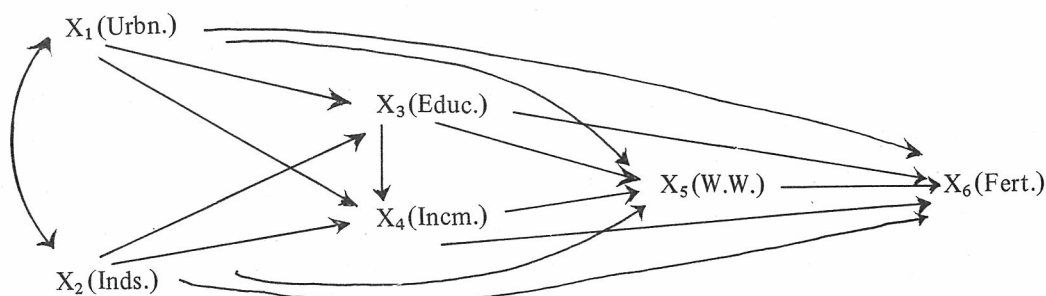
*Women Working*: percent females 16 years of age and older in the labor force.

## THE METHOD

In order to test the hypothesis of the inverse relationship between urbanization/industrialization and fertility through the three intervening variables, the technique of path analysis is used in this study. It can be seen from the postulated diagram (Figure 1) that the urbanization ( $X_1$ ) and industrialization ( $X_2$ ) are exogenous variables; that is, they are not determined by any other variables considered in this model. The other variables, education, income, women working, and fertility ratio, are endogenous, which means that they are influenced by at least one other variable in the model. The model itself is recursive; that is, the causal flow all moves in one direction with no untested or reciprocal links among the endogenous variables. The two-headed arrow linking  $X_1$  and  $X_2$  assumes that there is no causal priorities between them. The important features of this model are that urbanization ( $X_1$ ) and industrialization ( $X_2$ ) are viewed as having a positive impact on education ( $X_3$ ), income ( $X_4$ ), and women working ( $X_5$ ), and a negative effect on fertility. Education and income are viewed as having a direct effect on women working and a negative effect on fertility. Women working is viewed as causing a negative effect on fertility.

## RESULT AND DISCUSSION

The matrix of zero-order correlations for 1970 data is shown in Table 1. All five independent variables seem to be inversely correlated with the dependent variable. Except



where:

$$X_1 \text{ (Urbanization)} = e_1$$

$$X_2 \text{ (Industrialization)} = e_2$$

$$X_3 \text{ (Education)} = P_{31} X_1 + P_{32} X_2 + e_3$$

$$X_4 \text{ (Income)} = P_{41} X_1 + P_{42} X_2 + P_{43} X_3 + e_4$$

$$X_5 \text{ (Women Working)} = P_{51} X_1 + P_{52} X_2 + P_{53} X_3 + P_{54} X_4 + e_5$$

$$X_6 \text{ (Fertility Ratio)} = P_{61} X_1 + P_{62} X_2 + P_{63} X_3 + P_{64} X_4 + P_{65} X_5 + e_6$$

Figure 1. Postulated Structural Path Diagram for Puerto Rican Fertility, 1970

industrialization, all other variables have high correlation with fertility. The correlation for urbanization and fertility is  $-.4213$ , for education it is  $-.4477$ , for income,  $-.4445$ , for women working  $-.4250$ , which are statistically significant at .001 level. Industrialization shows a smaller magnitude of coefficient ( $r_{26} = -.2121$ ). At this point, the hypothesized inverse relationships between fertility and the independent variables seem to be supported. Yet, knowledge of these individual correlations can not fully explain the effect of urbanization and industrialization on fertility. Therefore, path analysis technique is used to assess the network of the hypothesized relationships and to isolate the direct influence of the variables on the fertility ratios.

Table 1 – Zero-Order Correlation Matrix for the Six Variables, Puerto Rico, 1970.

		X <sub>1</sub>	X <sub>2</sub>	X <sub>3</sub>	X <sub>4</sub>	X <sub>5</sub>	X <sub>6</sub>
Urbanization	X <sub>1</sub>	1.0					
Industrial'n	X <sub>2</sub>	.0714	1.0				
Education	X <sub>3</sub>	.7563	-.0802	1.0			
Income	X <sub>4</sub>	.7412	.1307	.9087	1.0		
Women Work'g	X <sub>5</sub>	.4480	.4493	.5675	.6882	1.0	
Fertility	X <sub>6</sub>	-.4213	-.2121	-.4472	-.4445	-.4250	1.0

The path coefficients and the recursive equations for the hypothesized relationships were shown in Figure 2, after negligible and insignificant paths were deleted from the original model. According to this model, 27 percent on the variations of fertility ratios are explained by industrialization, education, income, and the participation of women in the labor force. It can be seen from this model that four intervening variables show strong

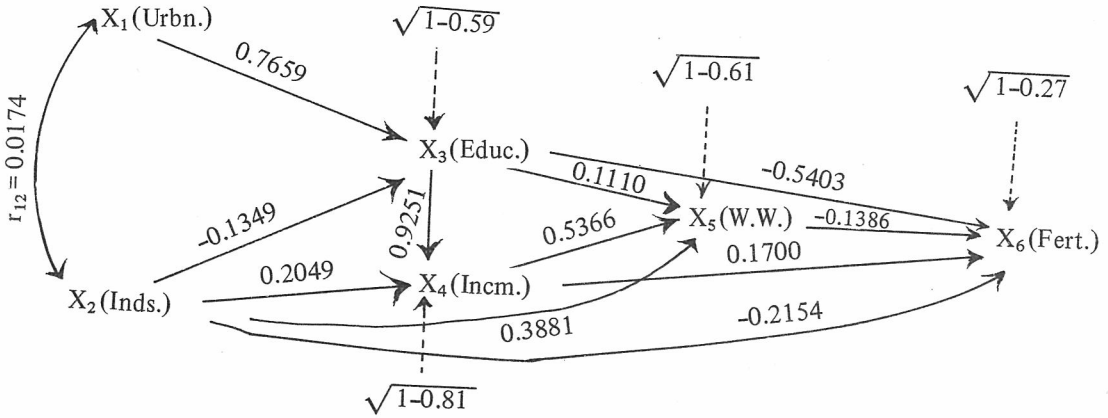


Figure 2. Revised Model with Path Coefficients, Puerto Rico, 1970.

influence on fertility. Among them, education shows the strongest direct influence on fertility ratio ( $P_{63} = -0.5403$ ). Industrialization and women working seem to be less effective than education ( $P_{62} = -0.2154$  and  $P_{65} = -0.1386$ ), but still consistent in our hypotheses — that is, both have negative effects on fertility level. Surprisingly, the result indicates that income acts positively to the influence of the levels of fertility ( $P_{64} = 0.1700$ ). This is contrary to our assumption. However, it should be pointed out that even though income had diminished its direct negative effect on fertility as shown in the analysis, the strong negative relationship between these two variables persists as manifested by a high significant correlation of  $r_{46} = -0.4445$  as shown in Table 1. Though industrialization has a negative effect on fertility as was pointed out before, urbanization does not show a significant and direct influence on the fertility ratio. However, urbanization has a strong positive effect on education ( $P_{31} = 0.7659$ ), and education, in turn, is inversely related to fertility strongly. Thus, education acts as an intervening variable between urbanization and fertility so that urbanization has an indirect negative influence on fertility. The path coefficients and their standard errors are listed in Table 2. Notice that  $P_{31}$ ,  $P_{42}$ ,  $P_{43}$ ,  $P_{54}$  and  $P_{63}$  have much smaller standard deviations than the rest of the coefficients. This implies that the relationships between urbanization and education ( $P_{31}$ ), education and income ( $P_{43}$ ), women working and income ( $P_{54}$ ), industrialization and income ( $P_{42}$ ), and education and fertility ( $P_{63}$ ) can be concluded more confidently. Relationships with

higher confidence are indicated in Figure 2 with heavier lines.

Table 2 – Path Coefficients and Their Standard Errors

$P_{31}$ (Urban.-Educ)	=	.7659± .149
$P_{32}$ (Indus.-Edu.)	=	-.1349± .0951
$P_{42}$ (Indus.-Income)	=	.2049± .067
$P_{43}$ (Edu.-Income)	=	.9251± .059
$P_{52}$ (Indus.-W.W.)	=	.3881± .123
$P_{53}$ (Edu.-W.W.)	=	.1110± .094
$P_{54}$ (Income-W.W.)	=	.5366± .094
$P_{62}$ (Indus.-Fert.)	=	-.2154± .153
$P_{63}$ (Edu.-Fert.)	=	-.5403± .115
$P_{64}$ (Income-Fert.)	=	.1700± .115
$P_{65}$ (W. W.-Fert.)	=	-.1386± .115

Approximately 59 percent of the variation in education is explained by urbanization and industrialization. For income, 87 percent of its variation is explained by education and industrialization. In this revised model, we found that industrialization had a negative influence in education ( $P_{32} = -.1349$ ). This suggests that higher degree of industrialization does not necessarily lead to higher education level. It might be explained that a higher concentration of individuals with low educational attainment in manufacturing enterprises. As to the relationship between income and education, they are strongly and positively related to each other ( $P_{34} = .9251$ ).

Of the variation in the proportion of women working, 61 percent is explained by the mutual association of industrialization, of education, and of income level. Income shows the strongest effect on women working ( $P_{54} = .5366$ ). Next in importance is industrialization ( $P_{52} = .3881$ ). Manufacturing industries were not the main sources of employment for women in Puerto Rico. This also indicated that females were probably employed in different occupations other than manufacture. Although there is a positive link between education and women working, the correlation is relatively low ( $P_{53} = .1110$ ).

Estimated correlation matrix from path coefficients and differences between original and estimated correlations are shown in Table 3. The predictability and internal mathematical validity of the model is excellent. None of the predicted  $r$ 's deviated from the 36 original correlations by more than 0.05 in magnitude. Thus, it seems that this model for 1970 Puerto Rico fertility ratio represents the actual correlations among the variables.

Table 3.— Estimated Correlation Matrix from Path Coefficients (above the Diagonal) and Differences Between Original and Estimated Correlations (below Diagonal) for Puerto Rico, 1970.

		X <sub>1</sub>	X <sub>2</sub>	X <sub>3</sub>	X <sub>4</sub>	X <sub>5</sub>	X <sub>6</sub>
Urbanization	X <sub>1</sub>	1.0	.071	.756	.714	.495	-.371
Industrial'n	X <sub>2</sub>	.000	1.0	-.080	.13	.449	-.212
Education	X <sub>3</sub>	.000	.000	1.0	.909	.567	-.447
Income	X <sub>4</sub>	-.027	.000	.000	1.0	.688	-.444
Women Work.	X <sub>5</sub>	.047	.000	.000	.000	1.0	-.425
Fertility	X <sub>6</sub>	.050	.000	.000	.000	.000	1.0

#### COMPARISON OF FINDINGS OF 1950, 1960 and 1970

In Table 4, the zero-order correlation matrices of 1950, 1960, and 1970 are presented together. The first impression is that the inverse correlations between fertility and the five indicators have been maintained and pervasive in the Puerto Rican society through time. The correlation between urbanization and industrialization drops sharply between 1960 and 1970. This can be explained in that the economic development on the island has reached a point where the correlation between urbanization and industrialization is no longer significant as it was at the earlier stages of economic development. Correlations among urbanization, education, and income have been highly significant in all three census years. In fact, the correlations showed a significant increase in 1970. The correlation between industrialization and education is undoubtedly insignificant as seen from the data. This is obvious since the industries hire all kinds of people — from unskilled laborers to college graduates.

Though Table 4 gives a comparison of the individual correlations in the three census years, it is more important to compare the path analysis results in order to understand fertility performance theoretically. Table 5 shows the comparison of those direct path coefficients to fertility ratio. Since 1950, urbanization has had no direct effect on the community's fertility level. Contrary to urbanization, industrialization did not have direct influence on fertility in 1950, but began showing increasing influences thereafter. Education has been always an important factor in determining a community's fertility level. The analysis shows that its effect on fertility has been a geometric progression at a period

Table 4.— Zero-Order Correlation Matrices of 1950, 1960,  
and 1970, Puerto Rico.

	Year	X <sub>1</sub>	X <sub>2</sub>	X <sub>3</sub>	X <sub>4</sub>	X <sub>5</sub>	X <sub>6</sub>	
Urbanization	X <sub>1</sub>	1.0						
Industrial'n	X <sub>2</sub>	1950	.2124					
		1960	.4060	1.0				
		1970	.0714					
Education	X <sub>3</sub>	1950	.5438	.0742				
		1960	.5567	.1092	1.0			
		1970	.7563	-.0802				
Income	X <sub>4</sub>	1950	.6314	.0332	.6706			
		1960	.5504	.4010	.7240	1.0		
		1970	.7412	.1307	.9087			
Women Work.	X <sub>5</sub>	1950	.1783	.8390	.1672	.0449		
		1960	.5525	.6548	.4891	.6844	1.0	
		1970	.4480	.4493	.5675	.6882		
Fertility	X <sub>6</sub>	1950	-.5204	-.3547	-.4602	-.4604	-.4541	
		1960	-.3348	-.3840	-.4659	-.5213	-.5348	1.0
		1970	-.4213	-.2121	-.4472	-.4445	-.4250	

of a decade ( $P_{63} = -.1236$  in 1950,  $-.2506$  in 1960 and  $-.5403$  in 1970). The negative effect of income on fertility decreases from  $-.1946$  in 1950 to  $-.1230$  in 1960. In 1970 its direct negative influence on fertility is no longer operating ( $P_{64} = .1700$  in 1970). With education becoming more and more important as an explanatory variable of fertility, the negative effect of income on fertility is being overridden and diminished. The effect of women working is also decreasing over the last three decades. Note that in 1950 women working was the strongest variable of fertility level while in 1970 it became second least effective variable—only more effective than urbanization.

According to the revised structural models of 1950, 1960, and 1970, respectively, 45 percent on the variations of fertility ratio in 1950 are explained by women working, urbanization, income, and education (relative importance in that order), 36 percent in 1960 are explained by education, women working, industrialization, and income, and 27 percent variations of 1970 are explained by education, industrialization, income and women working. As Rico-Velasco and Schwirian pointed out in their study of 1950 and



1960 census, the reduction in the ability to predict the variations in community fertility levels may indicate what happens in a society when communities' differentials in urbanization/industrialization, education, income, and the proportion of women working are reduced in the process of modernization or societal development, so that other factors such as religion, ethnicity, or psychological aspects become more important in explaining the fertility of population. As mentioned previously, education has become more and more important as an explanatory variable of fertility. Since a higher educational level increases the flow of communications of all types, including those specifically concerned with the the technology and consequences of birth control, it seems to indicate that recent social movements such as zero-population growth and women's liberation might have an impact on the community's fertility levels. The ability to predict the variations of fertility of our proposed model is therefore significantly reduced.

In addition to Table 5 which presents the comparison of direct path coefficients to fertility, Table 6 presents the comparison of the rest of the coefficients—those path coefficients to the three intervening variables: women working, income, and education. The impact of industrialization on the proportion of women working was at one time very large ( $P_{52} = .8195$  in 1950). With more sources of employment for women other than manufacturing industries, the impact of industrialization decreases. However, it still maintains a moderate influence on the proportion of women working even as of 1970 ( $P_{52} = .3881$  in 1970). Education has had a quite steady influence on women working as of 1970 as indicated by the data with a slight drop in the 1960's. The effect of income on women working changed from  $-.1000$  in 1950 to  $+.3622$  in 1960 and  $+.5366$  in 1970. Due to the limitation of path analysis that all causal flow moves in one direction, it has been assumed that levels of income determines the proportion of women working, but not the reverse. In reality, it can be intuitively understood that the relationship between income and women working is actually a closed-loop relation; i.e., income affects women working and vice versa. The positive coefficient values of 1960 and 1970 data as mentioned above, therefore might be explained as being backward, i.e., the more women working, the higher income of the population. These also indicate the increasing status of women in the society, since women are playing more important roles in determining the community's economic status.

In 1950, the income level was a function of urbanization and education only; in 1960 and 1970, education and industrialization became the two variables in determining the community's income level. The causal path between education and income had significantly increased between 1950 and 1970 ( $P_{43} = .4647$  in 1950,  $.6884$  in 1960, and  $.9251$  in 1970). In the process of modernization, such as in the case of Puerto Rico, urbanization had an important influence on income in the earlier years (in Puerto Rico, before

Table 5.— Comparison of Direct Path Coefficients to Fertility Ratios, Puerto Rico, 1950, 1960 and 1970.

Variable		Direct Path Coefficients to Fertility ( $X_6$ )		
		1950	1960	1970
Urbanization	$X_1$	-.2630	—	—
Industrial'n	$X_2$	—	-.1620	-.2154
Education	$X_3$	-.1236	-.2506	-.5403
Income	$X_4$	-.1946	-.1230	.1700
Women Work.	$X_5$	-.3777	-.2219	-.1386

Table 6.— Comparison of Path Coefficients to Women Working, Income, and Education, Puerto Rico, 1950, 1960 and 1970.

Variable		Direct Path Coefficients to Women Working ( $X_5$ )		
		1950	1960	1970
Urbanization	$X_1$	—	—	—
Industrial'n	$X_2$	.8195	.4960	.3881
Education	$X_3$	.1770	.1733	.1110
Income	$X_4$	-.1000	.3622	.5366
		Direct Path Coefficients to Income ( $X_4$ )		
Urbanization	$X_1$	.5787	—	—
Industrial'n	$X_2$	—	.3258	.2049
Education	$X_3$	.4647	.6884	.9251
		Direct Path Coefficients to Education ( $X_3$ )		
Urbanization	$X_1$	.5438	.6135	.7659
Industrial'n	$X_2$	—	-.1399	-.1349

1950). It lost its direct influence on the community's income thereafter, but still maintains its indirect influence through education. Industrialization, on the other hand, began its influence on income only after 1950. With the domination of education in determining the community's income, effect of industrialization on the community's income drops between 1960 and 1970 ( $P_{43} = .3258$  in 1969 and  $.2049$  in 1970).

While urbanization had had an increasing positive impact on the community's educational level ( $P_{31} = .5438$  in 1950,  $.6135$  in 1960 and  $.7659$  in 1970), industrialization did not show any direct impact upon education in 1950, and has shown a negative direct influence on education in 1960 and 1970 ( $P_{32} = 0.0$  in 1950,  $-.1399$  in 1960 and  $-.1349$  in 1970). This is expected since industrialization tends to cause higher concentration of individuals with low educational attainment in manufacturing industries.

In examining the ability to predict the variations of each variable, it is interesting to find that 70 percent of the variation of the proportion of women working in 1950 are explained by industrialization, education and income, 65 percent of the variation in 1960 and 61 percent in 1970 are explained by the same three variables—the ability of prediction in decreasing; while on the other hand, the ability to predict the variations of education and income is increasing. In 1950, only 55 percent of the variations of income were explained (by urbanization and education), 62 percent in 1960 and 87 percent in 1970 are explained (by education and industrialization). As to the educational level, only 29 percent of its variations were explained by urbanization in 1950, almost 33 percent were explained in 1960 and 59 percent in 1970, both by urbanization and industrialization. With the increasing ability to predict variations of education and income and the decreasing ability to predict that of women working and fertility, one must consider other factors directly affecting women working and fertility in further investigations.

### SUMMARY AND CONCLUSIONS

Overall, the findings of the relationship between modernization and fertility from the 1970 Puerto Rican census data seem to keep the same trend as found from the 1950 and 1960 data. Inverse relationship between urbanization, industrialization, education, income, and women working with community fertility level are being held for Puerto Rico. In the process of modernization, some of its empirical indicators change their influence on the society's fertility level. Since 1960, urbanization has lost its direct on fertility, and is distributing its effects indirectly through other variables such as education, income, and women working. For the past two decades, industrialization has increased its direct influence on fertility in addition to its indirect effects on fertility through income, education, and women working.

In the study by Rico-Velasco and Schwirian of the 1950 and 1960 data, it was predicted that in the process of modernization and societal development such as in the case of Puerto Rico, urbanization is expected to lose its direct influence on fertility. On the other hand, industrialization is expected to raise its negative direct effect on fertility ratios. Education is expected to play a more important role in directly affecting fertility than other variables. These predictions are proved to be true by the analysis of the 1970 data.

An interesting finding of this study is the significant decrease of the ability to explain the variances of fertility by using the proposed model with urbanization/industrialization, education, income and women working as indicators. This suggests that as the degree of modernization of a society increases, other variables should enter into the explanation of fertility differentials. For example, psychological aspects, religion, ethnicity, population policies adopted by the governments, and the progress of birth control technology should be taken into consideration.

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# 波多黎各現代化與生育率之再探討

吳淑娥\*

本文是以波多黎各 1970 年的普查資料再次地探討現代化與生育率之間的關係，文中並比較前人就 1950 年及 1960 年該國普查資料所做的研究發現。以一中度經濟發展的國家而言，波多黎各顯示出社區的生育率是一社會發展程度及時間的函數，此為本文的重點。研究結果指出從 1950 年至 1970 年間教育及工業化對生育率具有直接且漸增的負影響，而收入及工作婦女百分比的影響却漸減。都市化對生育率的直接影響自 1960 年後即消失，然而它却可透過其它的變項發揮其影響力。

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\* 美國 Kent State 大學助理教授。