Distribution, development, and education in Taiwan, 1979–94

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Massive investment in poor people's education is one of the few tools that seems to both accelerate economic growth and improve the distribution of income. This strategy has been recommended repeatedly in the development literature of the past 30 years, from the well-known *Redistribution with Growth* by Hollis Chenery and others in 1974 to the World Bank's influential 1990 and 2000/2001 *World Development Reports* on poverty. But although an important literature has developed on education's contributions to growth, relatively little is known about its effects on the distribution of income.[1]

This chapter provides an empirical framework for studying the relationship between the expansion of education and the distribution of income. This framework separates changes in the distribution of individual income and earnings that can be attributed to sociodemographic changes (especially changes in education), to changes in labor force participation and occupational choices, and to changes in the structure of earnings that may result from the supply of and demand for various types of workers. All this is done at the microeconomic level based on data from household surveys.

This analysis is applied to Taiwan, China (referred to hereafter simply as Taiwan), which is almost a perfect case study. It is one of the earliest and most dramatic development success stories where education played a leading role and was a powerful engine of growth. Indeed, education has expanded quickly in Taiwan. Between 1970 and 1995 the average formal schooling of the labor force increased by more than half, from 6.0 years—the level in many of

[1] On both subjects the analysis is essentially aggregate and cross-sectional. For an account of the relationship between education and growth see Pritchett (1996). On the relationship between education and income distribution see Bourguignon (1995).

This chapter is drawn from a [**research?**] project [**name it?**] funded by the World Bank. Companion papers include Bourguignon, Fournier, and Gurgand (1999a, b).

today's middle-income countries—to 9.5 years—a level comparable to that in developed countries.[2]

Taiwan is also somewhat remarkable in terms of income distribution because of its low inequality and limited variability. After a large drop in the 1950s and 1960s driven by successful land reform and reinforced by vigorous industrialization,[3] the Gini coefficient for individual income stabilized around 0.30 [**Ginis cited in some other chapters (such as Indonesia and Mexico) use whole numbers, while some (this chapter and the Brazil chapter) use decimals. Do you want the chapters to be consistent? If so, changes will need to be made throughout text and in tables and figures**]. This is the level still observed today. How the income distribution remained essentially the same despite drastic growth-related changes in the structure of the economy and in sociodemographic characteristics, including schooling, is the subject of this chapter. We identify various mutually compensating phenomena that explain the observed evolution.

Because Taiwan's experience in the 1950s and 1960s is one of the clearest cases of development with employment expansion and income equalization, there is a sizable literature on income distribution in Taiwan. But as noted by Chu (1997), a detailed study of the evolution of Taiwan's income distribution remains much needed for two reasons. First, the existing literature is at too much of an aggregate level to explain how income distribution may be affected by exogenous structural changes in the economy or in sociodemographic structure. Second, the literature tends to focus on a single aspect of the problem—trade, competition,

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[2] The 1970 figure is from Jiang (1992). The 1995 figure is ours and is computed from household surveys.

[3] This is the process so eloquently described and analyzed by Ranis (1974), Fei, Ranis, and Kuo (1979), and Kuo, Fei, and Ranis (1981 [**not in refs.—Fei, Ranis, and Kuo meant? Or should the refs. be changed?**]).

education—while ignoring other aspects and the way they interact to produce the observed change in the distribution of income.

Several authors have tried to overcome these difficulties, mostly through some decomposition of income inequality either by income source or income group at various points in time. Chu (1997) distinguishes two periods in Taiwan's recent history. Using a decomposition analysis based on a standard wage regression, he shows that the drop in wage inequality between 1966 and 1977 was accounted for about equally by changes in the education structure of the population and in the rate of return to schooling. Between 1981 and 1992 he finds that the distribution of household wage income remained stable but that household income became more unequal because of changes in participation behavior and in family composition.

Using another decomposition methodology based on Shorrocks's [**changed from Shorroks**] (1982) decomposition of inequality by income source, Fields and O'Hara (1996) find that the expansion of education in Taiwan between 1980 and 1994 helped reduce inequality in the distribution of human capital among individual earners. But the impact of this change on the distribution of earnings was mitigated by an increase in the returns to education.[4]

All these results indicate that beneath the surface of Taiwan's apparently unchanging distribution of income, powerful phenomena might have produced significant changes—but that those changes tended to offset one another. The reasons are complex. The expansion in education may not be independent from the changes in returns to schooling and in the structure of wages. But it may also be the cause of the changes in participation behavior and occupational choices. It is this chapter's goal to measure those effects and understand how they interacted.

[4] Based on a Blinder-Oaxaca methodology, the results obtained by Jiang (1992) for the early 1980s seem to go in the opposite direction. This finding suggests that the evolution identified by Fields and O'Hara might have occurred in the late 1980s and early 1990s.

Economic development, education expansion, and income distribution since 1979

Several features with potentially strong implications for the distribution of income are apparent in the recent evolution of Taiwan's sociodemographic structure (table 1). The population is becoming better educated, older, and more urbanized. At the same time, female labor force participation is increasing and household composition is changing.

Most of these changes have occurred at a striking pace. In 1979, 45 percent of the working-age population was under 30. By 1994 that share had dropped to about 35 percent [**changed from "less than a third" because table 1 shows 34.7 percent—OK?**]. During that time the share of working-age citizens with more than a secondary education almost doubled, to 17 percent. Conversely, the share of the population with a primary education or less dropped from 50 to 30 percent. Still more impressive is the average schooling of those age 30–50, which jumped from 6.9 years in 1979 to almost 10.0 years in 1994 (see table 1).

Also impressive is the rapid evolution of the population's urban-rural structure. During the period under analysis the share of working-age individuals living in agricultural households dropped by half, to 16 percent. This process corresponded to drops in the number and average size of agricultural households, which shrank from 5.7 to 4.4 people. The reduced importance of agriculture was among the forces driving other sociodemographic changes. It partly explains the smaller size of the average agricultural household, though nonagricultural households shrank as well. It also should have raised the overall participation rate because participation is traditionally lower in agricultural households. But it turns out that, on top of that, the participation rate of married women increased in both agricultural and nonagricultural households.

The change in the structure of GDP paralleled the change in the population. Extremely high growth in GDP in 1979–94—averaging 7.8 percent a year—was accompanied by a

dramatic change in its structure. First, agriculture became less important, dropping from 10 percent of GDP in 1979 to less than 3 percent in 1994. Until 1984 the shift from agriculture went to manufacturing, continuing the process observed since economic growth took off in the 1960s. But in the late 1980s industrialization came to an end and the "tertiarization" of the economy began. Between 1988 and 1995 manufacturing lost ground as a share of GDP in favor of services to businesses and, to a lesser extent, commerce and personal services.

Structural changes were not limited to aggregate sectors. Within manufacturing the deceleration of growth was associated with substantial changes in the importance of various activities. Starting in the mid-1980s traditional manufacturing sectors like food, textiles, and wood and paper products lost importance in favor of chemicals, metals, and electronics. Thus the period under study was one of intense structural changes in the economy and so in the demand side of the labor market—a rather constant feature of Taiwan over the past 40 or so years.

Given the big changes in Taiwan's social and economic structure and the speed at which they occurred, one would expect the distribution of income to also have undergone substantial alterations. Whether that happened depends on the definition used for income and income recipients. Income and earnings inequality in the 1980s and first half of the 1990s is shown in three ways in figure 1. First, the Gini coefficient for the distribution of equivalized household disposable income—that is, the distribution of individual incomes when every individual is given the disposable income per adult equivalent of the household to which he or she belongs—stayed fairly constant.[5] Second, the Gini coefficient for the distribution of equivalized household market income—that is, income before taxes and (public or private) transfers—showed a slight

[5] The equivalence scale used here is such that the number of adult equivalents in a household is equal to the square root of the number of household members.

increase that accelerated in the early 1990s. Finally, the inequality of individual earnings—excluding nonwage workers—started falling considerably in 1984.

Several studies have pointed to a recent increase in inequality, and it seems to have become a stylized fact that Taiwan's household income inequality increased in the early 1980s (Hung 1996; Chu 1997) while individual earnings inequality held constant and even declined. The increase is more apparent if the distribution is defined in terms of income per household (as in official statistics in Taiwan) rather than income per capita or adult equivalent.

This contradictory evolution of individual and household income distribution suggests that several forces helped change Taiwan's income distribution in the period under analysis. Because different definitions of the income distribution may give more or less weight to these forces, the definitions may lead to diverging views about whether inequality increased, decreased, or stayed the same.

Explaining the changing distribution of household income

Changes in the distribution of individual earnings and equivalized household income generally come from three sources.

- People with given characteristics (endowments) in a given occupation receive different incomes because remuneration rates (prices) in the labor market and possibly output markets have changed. We call this the price effect.
- People with given characteristics do not make the same occupational choices, so the population of earners is modified within and across households. This is the participation effect or occupation effect.

- The sociodemographic characteristics of households and individuals (say, in terms of education) change. This is the population effect or endowment effect.

The following decomposition methodology puts into evidence these various effects.

Decomposition principle

The income y_{it} of household i observed at time t is assumed to depend on four sets of arguments: its observable sociodemographic characteristics or those of its members (x), unobservable characteristics (ε), the prices and labor remuneration rates it faces (β), and a set of parameters defining the participation and occupational choice behavior of its members (λ):

$$y_{it} = Y(x_{it}, \varepsilon_{it}; \beta_t; \lambda_t) \qquad (1)$$

The overall distribution of household income at time t, D_t, is obtained by combining total household income y_{it} and some demographic characteristics included in x_{it}, such as household size or composition. Thus D_t may be expressed as a (vector) function of the distribution of observable and unobservable household characteristics at date t, the price vector β_t, and the vector of behavioral parameters λ_t. Let $H(\,)$ be that function:

$$D_t = H(\{x_{it}, \varepsilon_{it}\}, \beta_t, \lambda_t), \qquad (2)$$

where { } refers to the distribution of the corresponding variable in the population.

With such a definition of the overall distribution of household income, the effects defined above to explain the evolution of the distribution between two dates t and t' can simply be computed as follows:

Price effect: $$B_{tt'} = H(\{x_{it}, \varepsilon_{it}\}, \beta_{t'}, \lambda_t) - H(\{x_{it}, \varepsilon_{it}\}, \beta_t, \lambda_t) \qquad (3)$$

Participation effect: $$L_{tt'} = H(\{x_{it}, \varepsilon_{it}\}, \beta_t, \lambda_{t'}) - H(\{x_{it}, \varepsilon_{it}\}, \beta_t, \lambda_t) \qquad (4)$$

Population effect: $$P_{tt'} = H(\{x_{it'}, \varepsilon_{it'}\}, \beta_t, \lambda_t) - H(\{x_{it}, \varepsilon_{it}\}, \beta_t, \lambda_t) \quad (5)$$

In other words, the population effect is obtained by comparing the hypothetical distribution obtained by simulating on the population observed at date *t'* the remuneration structure and the behavioral parameters of period *t* to the actual distribution at date *t*. Similarly, the price effect is obtained by comparing the hypothetical distribution obtained by simulating on the population observed at date *t* the remuneration structure observed at date *t*' to the initial distribution.

All this is simple and can be seen as an extension of the Blinder-Oaxaca methodology to decompose the effects of discrimination between two groups of individuals into differences in mean incomes due to different mean characteristics of individuals in the two groups—that is, our population effect—and differences in how these characteristics are remunerated within each group—that is, our price effect. The main changes in our approach are that the decomposition is made on the full distribution rather than on means and that the income-generating model—function $Y(\ )$ in equation 1—may be more complicated than the linear regression model used by Blinder (1973) and Oaxaca (1973).[6]

Although the preceding definitions of price, participation, and population effects may seem elementary, the corresponding decompositions may be strongly path dependent. In particular, the price effect and the participation effect are likely to depend on the population used to evaluate them. In other words, it is generally the case that:

$B_{tt'} \neq B_{t't}$ $L_{tt'} \neq L_{t't}$ $P_{tt'} \neq P_{t't}$

For the same reason the decomposition of the change in inequality as the sum of the three preceding effects is not perfect:

[6] Juhn, Murphy, and Pierce (1993) propose a decomposition similar to this one with a linear income-generating function.

$D_{t'} - D_t \neq B_{tt'} + L_{tt'} + P_{tt'}$

For this decomposition to be nearly perfect, the structure of the population at dates *t* and *t'* as well as the price structure and the behavioral parameters λ should be close to each other, which is unlikely over the medium or long run in an economy subject to strong structural changes. In the application that follows this ambiguity is taken into account by considering simultaneously alternative possible definitions of the various effects.

We would also like to be able to decompose the population effect into what may be due to unobservable and observable characteristics. This should be easy once a model allowing for the identification of the unobservable terms ε_{it} is available. Assuming that unobservable characteristics are orthogonal to observable characteristics, it is possible to simulate a change in their distribution through rank-preserving transformations.[7] When this distribution is assumed to be normal with zero mean, this transformation is equivalent to $\varepsilon_{it} \rightarrow \varepsilon_{it}\sigma_{t'}/\sigma_t$, where σ_t is the standard deviation of the distribution at time *t*. It is also possible to identify what is due to a specific component of vector *x* in the population effect, such as individual education. This can be done by changing the individual values of that variable on one date to make its distribution—conditional on other variables—identical to that observed on another date. Again, this may be done through a rank-preserving transformation.

Modeling household incomes

The main difficulty of modeling household incomes in most developing countries arises from the fact that income may be obtained from different activities: wage income obtained by members employed outside the household, and farm or self-employment income for members working in

the household, possibly part time. To make the presentation simpler, we assume in the first stage that all household members can earn income only as wage workers.

Under the preceding assumption, let X_{mi} be the characteristics of person *i* in household *m* that determine his or her wage rate in the labor market and let u_{mi} be the associated unobserved determinants. Let also Z_{mi} be the characteristics of person *i* and those of other members of the household that may affect that person's labor supply. The basic form of the income-generating model for a household observed at period *t* is then given by:

$$Log\, w^t_{mi} = X^t_{mi}.\beta^t + u^t_{mi}$$

$$L^t_{mi} = Sup[0, \lambda^t_0.X^t_{mi} + Z^t_{mi}.\lambda^t + v^t_{mi}] \qquad (6)$$

$$y^t_m = \sum_{i=1}^{n_m} L^t_{mi}.w^t_{mi} + y^t_0$$

The first equation is a standard wage equation in which the coefficients and the distribution of the residual term, meant to represent unobservable determinants of earnings and possibly transitory components, depend on the period of observation. The second equation is a conventional labor supply function. This is a reduced form because labor supply does not depend explicitly on the wage rate an individual is facing but on the exogenous determinants, *X*, of that rate. Here again the residual term, v^t_{mi}, stands for unobserved components or possibly transitory effects. Finally, the third equation sums actual earnings over all household members and adds to it some exogenous income, y_0, to obtain total household income, y_m.

All the coefficients of this model, β and λ and the standard deviations of *u* and *v*, can be estimated using standard econometric techniques on data available at time *t*. But some caution

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[7] Formally, a rank-preserving transformation of the distribution of ε_{it} into the distribution observed at time *t'* is

must be taken because of the simultaneity between the wage and the labor supply equations and the fact that wages are observed only for people who actually work.

We use this basic model to simulate the following situation: what would have been the income of household *m* had it adopted at period *t* the labor supply behavior of period *t'*, or had earners been paid according to the wage equation observed at period *t"*? To answer that question, it is sufficient to modify the set of coefficients (β^t, λ^t) for the values observed in period *t'* while holding constant all the observed characteristics X^t_m and Z^t_m. For the residual terms, or the unobserved variables behind them, it is also assumed that adopting the behavior of period *t'* would have modified their absolute but not their relative value according to the rank-preserving transformation discussed above.

The only real difficulty in the preceding microsimulation occurs for people who were inactive in period *t*. For them no value is observed for the residual term v^t_{mi} or term u^t_{mi}. The solution involves drawing randomly the values of these two terms in a way consistent with the original model. So, the pair (u^t_{mi}, v^t_{mi}) must be drawn in the distribution estimated on the basis of active persons, which for simplicity may be assumed to be a normal bivariate, in such a way that the *Sup* condition in the second equation above is satisfied with $L = 0$. Once these two terms are available, it is simple to see whether the change in the wage equation (from β^t to $\beta^{t'}$) modifies the labor status of an inactive person and, if it does, how the income of the household is altered. The opposite case of an active person becoming inactive is easier to handle because it is not necessary to reconstitute the unobserved variables terms. Doing the same type of simulation with labor supply behavior or changing one individual characteristic following the methodology above raises no specific problem.

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obtained as follows: $e_{it"} = F^{-1}_{t'}[F_t(\varepsilon_{it})]$, where $F(\,)$ is the cumulative function of the distribution.

As noted, the actual household income generation model is slightly more complicated than the preceding model because household members may have to choose between activities. Adding the possibility that each household member devotes part of his or her time to the family farm or some other independent family business (such as retail trade) leads to the following model specification:

$$Log\, w_{mi}^{t} = X_{mi}^{t}.\beta^{t} + u_{mi}^{t}$$

$$L_{mi}^{t} = Sup[0, \lambda_{0}^{t}.X_{mi}^{t} + Z_{mi}^{t}.\lambda^{t} + v_{mi}^{t}]$$

$$L_{mi}^{At} = Sup[0, \lambda_{0}^{At}.X_{mi}^{t} + Z_{mi}^{t}.\lambda^{At} + v_{mi}^{At}] \qquad (7)$$

$$y_{m}^{t} = \sum_{i=1}^{n_m} L_{mi}^{t}.w_{mi}^{t} + \Pi[\beta_{A}^{t}, Z_{m}^{Tt}, \sum_{i=1}^{n_m} L_{mi}^{At}, \overline{X}_{m}^{t}(L_{m.}^{At} > 0), s_{m}^{t}] + y_{0m}^{t},$$

where L_{mi}^{At} stands for the labor supplied by member *i* in the family farm or business and depends on the same variables as wage labor supply, L_{mi}^{t}; $\Pi(\,)$ is the associated profit function. As written, this function depends on household characteristics, Z_{m}^{t}, that describe cultivable land or nonfarm business capital available, total family labor input, mean personal characteristics of members who work in the family business, $\overline{X}_{m}^{t}(L_{m.}^{At} > 0)$, and unobservable variables, s^{t}_{m}. It also depends on a set of coefficients β_{A}^{t} that can be interpreted as the price or remuneration rate of the preceding factors. Except for that profit function, the other differences with the previous model are that there are now two labor supply functions and the set of labor supply parameters, λ, has been expanded. There is now a set of coefficients describing wage labor supply and another set, λ^{A}, describing the supply of labor to the family farm or nonfarm business.

The structure of the model is now complete. The full model (11 [**meaning? 7 meant, as above and below?**]) plays the role of the income-generating function $y_{it}=Y(x_{it},\varepsilon_{it};\beta_t;\lambda_t)$ used above in the description of the decomposition principles with the following set of equivalence between notations. Observable characteristics x_{it} now correspond to a household's general characteristics and those of its members observed at period *t*, respectively Z^t_m and X^t_{mi}. Unobservable characteristics ε_{it} are summarized by the set of residual terms (u^t_{mi}, v^t_{mi}, v^{At}_{mi}, s^t_m) that enter the individual earnings functions, individual labor supply equations, and household profit function in case it engages in farm or independent business activities. The price system includes the coefficients of the earnings equations β^t and of the profit functions β^A_t. Finally, the set of behavioral parameters λ_t is the set of coefficients that enter the labor supply functions and the profit functions—that is, (λ^t, μ^t, λ^{At}, μ^{At}).

It is important to stress that model 7 is reduced form rather than structural in the sense that the labor supply functions do not depend explicitly on the remuneration of labor in each possible activity. So, price effects affect individual and household incomes only directly through the earnings and profit equations, and not indirectly through changing occupational choice.[8]

Econometric specifications

Estimating the complete household income model (11 [**again, 7 meant?**]) in its general form is almost impossible, or would be a formidable undertaking. There are several reasons. First, all the equations of the model must be estimated simultaneously with nonlinear estimation techniques due to the nonnegativity constraint on labor supply and the likely correlation between unobservable characteristics or the residual term in the various equations. Although intricate, this

[8] A structural model is used in Bourguignon, Fournier, and Gurgand (1999b).

might be manageable—under some simplifying assumptions—if there were a single individual in every household. But the obvious correlation across the earnings equations and labor supply equations of the working-age members of a given household, whose number varies across households, makes things hopelessly complicated. An additional risk is that the results of such a complex model would not be especially robust and would show artificially high time variability, jeopardizing the decomposition principle shown above.

The microeconomic estimation work undertaken for Taiwan relies on a simplified but more robust specification based on the following principles:

- Individual earnings functions and household profit functions, if applicable, are estimated separately and consistently through the instrumentation of endogenous right-hand-side variables and correction of selection bias. Residual terms of these functions are assumed to be independent within any household.
- To compensate for missing data on hours of work, labor supply behavior is estimated in a discrete way. Household members are assumed to choose among inactivity, wage work, work on a family farm, work in a family nonfarm business, or combinations of wage work and work on a family farm. This choice is specified as a multinomial logit model that can be considered an approximation of the more structural model 7.
- The simultaneity between household members' labor supply decisions is taken into account by considering sequentially the behavior of household heads and that of other members, as is conventionally done in most of the labor supply literature. Thus the labor supply decision of the household head is estimated first with the preceding multilogit model and using both the general exogenous characteristics of the household and those of all members as explanatory variables. Second, the labor supply decision of other members is estimated conditionally on the decision

made by the head, and possibly his or her income if he or she is engaged in wage work. In addition, different models were estimated depending on a person's position in a family. Indeed, it seems natural that, other things being equal, the spouse of the head does not behave in the same way in terms of labor supply as his or her daughter. The categories for which distinct labor supply models have been estimated are spouses, sons, daughters, and other household members.

- It would have been possible to use the results of the multilogit labor supply models to control for selection in the estimation of earnings equations and profit functions.[9] The usual Heckman two-step procedure with an intermediate Probit estimation of the probability that an individual is a wage worker or not (whether a wage worker or combination wage worker and farm worker) led to equivalent results.
- The lack of robustness of estimates of some coefficients in the various behavioral equations of the model and the corresponding variability over time would introduce some noise into the decomposition technique described above. Say that the coefficient of a regional dummy variable (such as working in the Taipei area) in the earnings equation is imprecisely estimated. The estimate of this coefficient will thus tend to vary widely but not significantly from one year to the next. As a result the decomposition method will falsely impute to changes in the geographic structure of earnings part of the observed changes in the distribution of household income. To avoid this, all the original estimates obtained in the various cross-sections have been submitted to the following "time smoothing" treatment. For each series of estimates c^t of a coefficient of the model, a simple regression was run on a time polynomial of order 2:

(8) $$c^t = a_c + b_c.t + d_c.t^2 \qquad (8)$$

Only the terms significantly different from zero in this regression were kept, and the original estimates c^t were replaced by the value predicted by the preceding equation. All the behavioral equations were then rerun to adjust the intercept accordingly.

Changes in earnings and labor supply functions, 1976–94

[**shouldn't the heading say 1979 rather than 1976? years have been dropped from other headings because they appear in the chapter title—should they also be dropped here, assuming that 1979 is meant?**]

Discussing in detail the results of the estimations of the preceding models would take too much space. We sketch here only those conclusions drawn from the estimation work that are important for understanding the decomposition of the change in the income distribution shown in the next section.[10]

Three changes are of major importance for understanding the evolution of Taiwan's income distribution since 1979: an increase in the returns to schooling in earning equations, a drop in the variance of the residual term of the earnings equations, and a reduced dependence of spouses' labor supply and occupational choice on household heads' income and occupation. We analyze each change in turn.

Table 2 reports estimates of standard Mincerian earning [**"earnings equations" meant?**] for various years of the period under analysis. Education is specified alternatively as the number of years of schooling or as a set of dummy variables corresponding to various schooling degrees,

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[9] An equivalent to the well-known Heckman two-stage procedure for the correction of selection bias in the case of a dichotomous choice represented by a Probit exists with polytomous choices and the multilogit model; see Lee (1983).

to take into account the possible linearity of the (log) relationship between earnings and education.[11] Experience is defined in the usual way as age minus years of schooling minus six. Other variables include a dummy variable for wage earners who also work as family farm workers—in the absence of data on hours of work these are the only wage workers who can be assumed to be employed part time—and the Mills ratio, which controls for selection into wage-earning jobs. The first variable is instrumented by all variables appearing in the occupational choice model—that is, all individual and household characteristics. The Mills ratio is computed based on a Probit model in which wage work is the dependent dummy variable and explanatory variables are again all the variables appearing in the occupational choice model.

The striking result in table 2 is the increasing trend in the coefficient measuring the returns to education for both men and women over the period under analysis. Roughly speaking, over the 14-year period analyzed here, the rate of return for an additional year of schooling increased from a little more than 3 percent to [**add "almost"?**] 6 percent for men, and from [**add "almost"?**] 6 to almost [**change to "more than"? for all three queries, see table 2**] 8 percent for women. Judging from the coefficients obtained by specifying schooling as a set of dummy variables for the various degrees, the structure of earnings by education level changed substantially over the period. The earnings differential between people with higher secondary or university education and workers with primary or lower secondary education increased considerably—more than proportionally to the numbers of years of schooling. From the coefficients in table 2 it can be determined that the marginal return by year of schooling increased significantly at the upper secondary level and for university education but remained

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[10] Bourguignon, Fournier, and Gurgand (1999a) provide more detail on the estimation work and its results.

[11] All simulations in the next section rely on the most complete specification with dummy degree variables.

constant for lower secondary education and even dropped for primary education. This evolution was more pronounced for women than men.

Previous studies of Taiwan's wage structure do not contradict these results, though they point to a somewhat milder unequalizing trend. Using labor force surveys of Taiwan for 1978–91, Gindling, Goldfarb, and Chang (1995) find a gradual increase in the earnings differential between upper and primary education graduates until 1988 for men and a small drop afterward, and a continuous increase until 1991 for women. Using the same data source, Fields and O'Hara (1996) find that the coefficient of the number of years of schooling in the typical log wage regression increased significantly from 0.050 in 1980 to 0.057 in 1993 in a sample including both men and women.[12]

The evidence from household surveys on the increase in returns to education is thus more pronounced than that from labor force surveys. A possible reason is that the number of hours of work is not observed in the household surveys, but is explicitly taken into account in the studies just mentioned. These studies also use other variables not available in the household surveys, such as tenure in the current main job, job mobility over the previous five years, and whether the person has a second job. A possible explanation for the stronger increase we found in the coefficient of education would be that the correlation between all these variables and education may have changed systematically over time. Our specification would thus appear as some kind of reduced form of more complete earning models.

From a macroeconomic perspective the increase in returns to education may seem surprising. It suggests that the demand for educated workers increased faster than the supply,

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[12] Jiang (1992) finds a "wage compression effect" across education levels between 1978 and 1986, though he also uses the labor force surveys. But his conclusion is likely due to the fact that he simultaneously controlled for the

which grew at an accelerated rate over the period under analysis. The growth in demand relates to the economy's growth rate but also to the change in its structure, which has been dramatic.

The second striking feature in table 2 is the drop in the variance of the residual term of the earnings equations. Since the analysis of Juhn, Murphy, and Pierce (1993) for the United States it has become customary to interpret this term as representing the dispersion in the remuneration of unobserved productive talents. In Taiwan the evidence would thus suggest that unobserved talents were remunerated in a more homogeneous way in the 1990s than in the late 1970s. But it is not clear that this would be the correct interpretation. It must be kept in mind that we control very badly in the earning equations for hours of work. We essentially do so through a dummy variable indicating that a wage earner has a self-employment activity and implicitly through the selection bias correction factor, which in some sense can be interpreted as linked to labor supply.[13] Under these conditions it is possible that the reduced variance of the residual term of the earnings equations corresponds to more homogeneity in the working hours of wage earners. To check whether this is actually the case would require reestimating earnings equations with another database that includes hours of work. For our decomposition purpose there thus remains an ambiguity about the actual interpretation to be given to the drop in the variance of this residual term.

Income regressions were also estimated for farm and nonfarm profit functions. None show significant changes over time. In particular, returns to schooling show no significant change. Because the self-employed tend to be concentrated near the bottom of the education

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sector of activity of wage earners and their occupation, both variables being highly correlated with formal education.

[13] In other words, the latent variable in a Probit participation model may be interpreted as proportional to the desired number of hours of work.

scale, this finding is consistent with the findings for wage earners. For lack of space these regressions are not reported in this chapter.

The last major change in the estimated household income model involves the occupational choices of married women. As noted, this choice is modeled through a multinomial logit model. Explanatory variables include sociodemographic characteristics of the household head (gender, age, education), the sociodemographic composition of the rest of the household, the area of residence, land ownership, and financial wealth, approximated by capital income. Different models were estimated for household heads, spouses, and other household members.

Going into the details of all these models would be cumbersome. We focus here on a single change: the increasing autonomy of married women in their occupational choices. Figure 2 shows the evolution of the estimated mean elasticity of the probability that married women take up various occupations relative to their husbands' earnings—if the husband is indeed a wage worker [**see query on figure 2 about its title—should it refer instead to wives and husbands?**]. These women's choices became increasingly less dependent on their husbands' income, especially for wage work and self-employment and to a lesser extent for participation. If we were to restrict the sample to households where the head is a wage earner—about 75 percent of the population—the correlation between husbands' and wives' incomes tended to increase over time, with fewer wives being inactive or having low-paid self-employment jobs in households where heads have a relatively high wage.

This change may be explained on the one hand by the general increase in female labor force participation and on the other by the increase in wage employment opportunities permitted by economic growth. In both cases the new jobs were taken by women who initially were less

likely to be active or to be employed as wage workers. Other things being equal, they were predominantly in households with relatively well-off household heads.

Other notable features in the coefficients of the occupational choice models are likely to have influenced the evolution of the income distribution. But they are quantitatively less important, and we prefer to leave them aside for the clarity of the argument.[14]

Decomposition of changes in the income distribution

We now apply the decomposition methodology presented above, providing evidence on the separate effects on the income distribution of changes in the structure of wages and prices, in labor supply behavior and occupational preferences, and in the structure of the population. To make the analysis clearer, we consider only the initial and final years of the period under analysis. But because the decomposition methodology is sensitive to the sample chosen, we use combinations of the two initial years (1979 and 1980) and the two final years (1993 and 1994) and apply the methodology using alternatively the initial and the final years as the reference sample.

This approach leads to eight possible ways of defining the price, participation, population, and education effects,[15] allowing us to identify rough "intervals of confidence" for these various effects or, alternatively, to measure the extent to which they are sensitive to the

[14] Bourguignon, Fournier, and Gurgand (1999b) provide a detailed discussion of these models as well as of the household profit functions.

[15] That is, four combinations of initial and final years, and for each combination two decompositions depending on whether the initial or final population sample is used as a reference.

population chosen as a reference. Tables 3 and 4 report the mean changes in the Gini coefficients computed on these eight values as well as the minimum and maximum changes.[16]

Evolution of the distribution of individual earnings

The results of the decomposition methodology applied to individual earnings are summarized in table 3 for Gini coefficients and figures 3–5 for the full distribution.

The price effect and the unequalizing effect of higher education returns. The first step in the decomposition consists of modifying the structure of earnings while keeping constant the population of wage earners. In doing so, we ignore the possible effects on participation and occupational decisions of a change in the level and structure of earnings.

The dominant effect in the evolution of the structure of earnings is the observed increase in the returns to education. Not surprisingly, this increase produces an unambiguous increase in the inequality of the distribution. Depending on the population used to evaluate this effect, the change in the Gini coefficient ranges from 0.016 to 0.034, with an arithmetic mean of 0.025 [**As above, for consistency with other chapters would it be possible to change these to whole numbers, here and in the table? (1.6, 3.4, 2.5)**]. There is nothing surprising in the amplitude of this range. It is to be expected that the effect of a change in the returns to education on the distribution of earnings depends on the distribution of schooling in the population, which in Taiwan changed drastically between 1979 and 1994. The effect of a rising earnings differential between highly and poorly educated workers depends on the weight of each group in the population, and these weights were much different in 1979 and 1994.

[16] Shorrocks (1999) shows that focusing on the average may be justified by an argument relying on Shapley values.

Figure 3 provides another representation of the unequalizing effect of the increase in the returns to education. It shows the simulated change in earnings of individual wage workers observed in 1979 if they had been paid in accordance with the earnings function observed in 1994. Average earnings would have increased about 70 percent, but because of the rise in the returns to education, the gain in earnings is an increasing function of the rank in the distribution. Earners in the bottom quartile would have gained slightly more than 60 percent over the period—while earners in the top quartile would have gained about 75 percent.

Most of the preceding evolution is due to the change in the structure of earnings by education level. Changes in returns to experience or in geographic earning differentials were too small to have any sizable effect on the distribution.

The equalizing effect of changes in participation and occupational choice. The effects of changes in participation and occupational choice behavior are a bit more subtle than the pure price effects above because they correspond to a modification of the population of individual earners. Figure 4 represents these modifications by showing the entries to and exits from the 1979 wage labor force that would have occurred had people adopted the participation and occupational choice behavior observed in 1994. Considering all wage earners at the same time, we first see in figure 4a that there has been an equalizing effect, with net exits from the wage labor force at the two extremes of the distribution and no net change in the middle.

This pattern results from various phenomena, particularly opposite tendencies between men and women. The participation of men in the wage labor force fell, mostly because of earlier retirements. This net drop in participation is fairly constant along the male wage scale but is a bit more pronounced in the first two deciles (see figure 4b). But because there are more men than

women at the top of the distribution of wage earners, this drop is responsible for a higher net exit rate at the top of the distribution (see figure 4c).

For women there were more entries than exits because of the participation effect noted above. This phenomenon tended to be stronger at the top of the female wage scale and actually moved in the opposite direction in the bottom percentiles (see figure 4d). But because women fall at the bottom of the overall wage distribution, this phenomenon contributed to a net entry of wage workers at the middle of the wage scale and so was equalizing (see figure 4e). Overall, the change in participation behavior—which essentially consisted of a drop in the wage labor force participation of men and an increase in that of women—had an unambiguous equalizing effect on the overall distribution of individual earnings.

The equalizing effect of the drop in residual earnings variance. This effect corresponds to a rather tautological step in the decomposition methodology. We have seen that earnings heterogeneity as described by the residual terms of earnings equations fell substantially, reflecting either increasing homogeneity in the productivity of workers with identical observed characteristics or less disparity in working hours. The only lesson to be drawn from the decomposition in table 3 is that this effect is responsible for a drop of 2.2–3.8 percentage points in the Gini coefficient of individual earnings—a rather sizable effect.

Population and education effects [**consider making these subheadings and those in the following section more descriptive, as with the subheadings above**]. Taking the preceding effects out of the actual change in the Gini coefficient of the distribution of individual earnings

yields the population effect as a residual. This residual amounts to about a 1 percentage point drop in the Gini coefficient. But more than for the preceding effects, this effect heavily depends on the path followed in making the decomposition of the change in inequality.[17] Thus there is some ambiguity in concluding that the change in sociodemographic structure helped equalize the distribution.

More interesting, and much less ambiguous, is the effect of the change in the population's education structure. On average it represents a little more than a 1 percentage point drop in the Gini coefficient of individual earnings, with a rather narrow range of variation.

An illustration of how the change in the population's education structure modifies the distribution of individual earnings is provided by figure 5, which is built along the same lines as figure 3. Here again the starting point is the 1979 population. We apply to that population the distribution of education observed by gender and age group in 1994. As noted, this is done through a rank-preserving transformation. The most educated person in a gender or age group in 1979 is given the education level of the most educated person in the same group in 1994, then the same thing is done with the next most educated person, and so on.

Figure 5a shows the change in earnings that would have resulted from this modified level of schooling for the 1979 population of wage earners. This simulated change in the level of schooling also modifies people's participation and occupational choice behavior, so figure 5a refers only to wage workers in 1979 who would have remained wage workers despite the change in their education level. It does not include workers who, being initially inactive or in a nonwage activity, would have entered wage work because of more schooling.

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[17] It could also depend on the choice of the initial and final years, but closer scrutiny shows that path dependence is the main source of ambiguity.

Figure 5a shows that the change in a population's average level of schooling is not distribution neutral. Because there is a limit to the number of years of schooling, people initially at the top of the wage scale—and so better educated—gained proportionally fewer years of schooling than people initially at the bottom with a low level of schooling. It follows that the expansion of schooling had a significant equalizing effect on the distribution of individual earnings. Roughly speaking, this evolution may have caused a 10 percent increase in earnings among the bottom half of the distribution, and only 5 percent among the top half.

The change in the structure of schooling also caused changes in participation behavior. One of these changes is purely mechanical. With the expansion of education, young people stay in school longer and participate in the labor market less. This adjustment produces "exits" from the wage labor force that are concentrated at the bottom of the distribution since young people concerned with this effect receive relatively low wages.

The second change is more economic. With higher schooling and higher market wages, more individuals enter the wage labor force. This phenomenon is more or less uniform across the wage scale for men and concentrated a bit more at the bottom of the distribution for women. On balance, the expansion of education produces net exits from the wage labor force at the bottom of the distribution and net entries at the top (see figure 5b). In terms of inequality this has ambiguous effects, with poor people getting poorer but less numerous. The second effect tends to dominate with the Gini coefficient. This explains why the drop in inequality due to the education effect tends to be lower in table 3 when occupation or school enrollment are kept fixed.

That the sum of these two effects on the income distribution is unambiguously equalizing is shown by figure 5c. The difference between figures 5a and 5c is that in figure 5c exits from and entries to the wage labor force have been taken into account at the same time as individual

earnings were modified because of the change in schooling. This leads to a redefinition of the percentiles of the original 1979 distribution because the population is not the same and some income reranking may have occurred. So we are now comparing percentiles of individual wage earners with a different composition. The relative income gain is still a decreasing function of the wage level, so the Lorenz curve of the simulated wage distribution in 1994 dominates that of 1979. For the bottom percentiles the effect is substantial: nearly 17 percent. This is not out of proportion with the 60 percent [**shouldn't this be a bit higher than 60 percent?**] pure price effect in figure 3, which may be interpreted as a pure productivity effect.

The changes in the Gini coefficient in table 3 are consistent with this analysis of the effect of the expansion of education on the income distribution. But an additional and seemingly puzzling effect appears there. It is a strong asymmetry between the effects of the expansion of the education of men and women on the overall distribution of earnings. There is no paradox here, however: it is simply the consequence of an earnings differential in favor of men. Given that differential, increasing the education of men but not that of women would have the equalizing effect seen above but would also increase inequality between men and women. The second effect dominates the first. The opposite occurs for women. The equalizing effect of the expansion of education is reinforced by the reduction in the male-female differential.

Thus it appears that the fall in the inequality of individual earnings in Taiwan over 1979–94 resulted from several strong influences that did not all play in the same direction. On the unequalizing side were the increasing returns to education, which reinforced earnings disparities. On the equalizing side three phenomena of unequal importance overcompensated for the preceding evolution. By order of importance they were the drop in the variance of the unobserved determinants of earnings, the change in schooling and in the distribution of

schooling among wage earners, and the change in participation and occupational choice behavior, which brought more women into the wage labor force and took out some men. The latter evolution was equalizing because of the initial earnings gap in favor of men.

Evolution of the distribution of household income

The decomposition of the evolution of the distribution of equivalized household incomes along the same lines does not lead to the same conclusions. In fact, the balance of all the preceding effects is the opposite of what was found for individual earners because the distribution of equivalized household income became substantially more unequal over the period under analysis. In what follows we review the same issues as for individual earnings and try to identify where the difference may lie.

Price effects [**see note above on using descriptive headings for this section**]. The increase in returns to schooling should have the same unequalizing effect on household incomes as on individual earnings, but its magnitude may be expected to be smaller. Though there is some correlation between the level of schooling of the various members of a household, the correlation is not perfect, which is equalizing. In addition, returns to education remained fairly stable in farm and nonfarm profit functions. This effect should somewhat dampen the effect of increased individual wage inequality on household incomes. This dampening may be compensated by changes in the coefficients of profit functions that would contribute to more inequality among households receiving this type of income.

Although the latter effects were not substantial, they seemed to compensate for the dampening effect on wage inequality of switching from household to individual incomes. The

increase in the Gini coefficient attributable to the price effect is about the same for households as for individual earners—2.4 percentage points. The lower bound of the confidence interval is smaller, though. Similarly, the curve in figure 6 showing the 1979–94 price effect on the distribution of household income is flatter than the curve in figure 3.

Participation effects. The difference between individual and household earnings is even more pronounced for participation effects. Changes in participation and occupational choice behavior that were unambiguously equalizing for individual earnings are not so for household earnings. As can be seen in table 4, they are even unequalizing.

Two phenomena explain this difference. The first was alluded to in the preceding section and is analyzed in some detail in Fournier (1997). It is the drop in the (negative) income effect of husbands' incomes on married women's labor force participation. Because of that evolution we expect that applying the participation and occupational choice behavior of 1994 to the 1979 sample of households will lead to more women entering—in net terms—the labor force at the top of the distribution of household incomes, where heads' earnings are relatively high. This is exactly what appears in the first panel of figure 7, which shows the variation in income by percentile due to simulated entries to and exits from the labor force of 1979 households ranked by equivalized income.[18]

But there is another explanation. Figure 4d shows that women who entered the wage labor force between 1979 and 1994 were on average better educated than women who were

[18] Note that figure 7 is the equivalent of figures 4b and 4d for individual earners, with two differences. First, entry and exit are defined relative to the entire labor force (that is, participation) rather than the wage labor force. Second, individuals entering or leaving the labor force are ranked according to the equivalized income of the household they belong to rather than their own actual or potential wage.

already active. This had an equalizing effect on the distribution of individual earnings because better-educated women were in the middle of the overall wage distribution. Things are different for household incomes, however. Better-educated women tend to be in richer households, and their entry into the wage labor market contributes to a larger increase in household income at the upper end of the distribution.

Nothing of this type is observed for men. As noted, they tended to exit the labor force in a more or less neutral way relative to the distribution of male individual earnings. The second panel in figure 7 suggests about the same neutrality relative to household income. This outcome is not unexpected. Indeed, household incomes are generally well correlated with the income of household heads, who are generally male. Overall, then, the change in female labor force participation explains most of the unequalizing effect of changes in participation and occupational choice behavior on household incomes.

The effect of residual earnings variance. As for the effects of the returns to education noted above, the fact that there are various wage earners in a household should reduce the distributional impact of this drop in the variance of the unobserved determinants of individual earnings. This outcome is observed in table 4. The drop in the Gini coefficient of equivalized household income is just 0.020, while it was 0.029 for individual earnings.[19]

[19] No attempt was made to simulate the effect of observed changes in the variance of the residuals of farm and nonfarm profit functions because this change was very small.

Population and education effects. Another important difference between the decomposition of the evolution of individual and household earnings is that the effect of changes in sociodemographic structure on the distribution of household incomes is close to zero when the Gini coefficient is used to measure income inequality. Alternatively, one may say that the interval of confidence in table 4 suggests a much more ambiguous effect, while that same effect was almost unambiguously equalizing for individual earnings.

What is more puzzling is that this ambiguity holds when one focuses on the effect of the change in the population's education structure. Indeed, that change was unambiguously and strongly equalizing for individual earnings. This difference is explained on the one hand by the fact that the change in education structure may be expected to have a less equalizing effect for household income than for individual earnings because of the diversification of education changes within the household. It is explained on the other hand by the presence of additional unequalizing effects that were not present for individual earnings.

As in the arguments above about the price effect and the residual variance, the less equalizing effect of the expansion of education observed with household income corresponds to the diversity of initial individual levels of schooling within a household. If schooling levels were perfectly correlated across the various members of a household, the income equalizing effect of the expansion of schooling would be the same as for individuals. At the other extreme, if schooling levels were totally uncorrelated, the expansion of schooling would have the same income effect on all households, so the distribution would hardly change.

Reality falls somewhere between these two extremes. When the effect of the expansion of education is evaluated with fixed occupations—in other words, when only the income effect of an increase in education is taken into account—the distribution of household income

unambiguously improves. But the change in the Gini coefficient is smaller than for individual earners. In table 4 this change is –0.4 percentage points, with a confidence interval ranging from –0.3 to –0.6. This change was –0.8 percentage points in table 3. But it is likely that we slightly overestimate the equalizing effect of the expansion of education on household income because changes in individual schooling levels were simulated independently among members of the same household, while some partial correlation should have been taken into account.

Unlike with individual earnings, participation effects induced by the change in the distribution of schooling have little influence on the distribution of equivalized household income (figure 8b). The proportion of net exits from the labor force, which results from more people going to school longer and from more people participating because of their increased earning potential, turns out to be about the same across income groups. Gross flows in and out of the labor force are strongly income dependent, however, with larger flows at the highest income levels.

The explanation for this is rather simple. First, the drop in participation due to longer schooling and more school enrollment can be observed only for individuals going to school long enough for the choice between schooling and activity to be truly relevant. For instance, 18-year-olds are more likely to switch from activity to school because of the general expansion of education in richer households. This is because a larger portion of children were already attending school until age 17 in richer households. Second, the increase in the level of education among older people led some of them to enter the labor force. This phenomenon is stronger among women who reach higher levels of education and so find themselves in relatively well-off households.

The overall effect of the expansion of education is shown in figures 8a and 8c. In figure 8a individuals are ranked according to the 1979 level of equivalized income in the household to which they belong. This figure shows the average change in income due to both higher earnings and profits of active household members and changes in participation behavior. The drop in income due to less participation is overcompensated by the higher income of active people at low initial income levels—but not at the other end of the distribution. Based on figure 8a, it would seem that the expansion of education is unambiguously equalizing even when one takes into account its consequences for labor force participation. But the argument behind figure 8a ignores the fact that those changes in participation are bound to generate some substantial reranking of households.

Actually, exits from the labor force caused by longer schooling are responsible in some households for a substantial drop in income that may change the ranking of households. Symmetrically, more participation may explain that a household shifts to a higher percentile. So, the bottom percentiles of the new distribution include many households whose income has fallen because of the negative participation effect of longer schooling.[20] At the top of the distribution one should find some households in which an additional member switched from inactivity to work or from self-employment to wage work because of the change in his or her level of schooling.

It can be seen in figure 8c that this reranking causes an ambiguous change in the distribution of income. On average households in the lower percentiles of the 1979 distribution gained with the expansion of education (see figure 8a), but some lost a lot because a member

became inactive. As a result those households shifted toward the bottom of the distribution, and the lower percentiles of the distribution appear poorer than they were in 1979. Thus the effect of the expansion of schooling on the distribution of household income is essentially ambiguous—a conclusion in direct opposition to that for individual wage earners. Isolating this school enrollment effect, as in table 4, confirms that it increases inequality.

This conclusion may seem surprising, and one may wonder whether it is built into the methodology being used. Clearly, this conclusion may have to do with the absence of an explicit model of household demand for schooling in our decomposition methodology, and so with the fact that changes in schooling and their implications for participation are allocated randomly and uniformly in the population. Practically, there certainly was some selection in the expansion of schooling, with schooling expanding less among poorer households. But the expansion of schooling over the period under analysis was so large that it is difficult to imagine that such temporarily unequalizing forces were not present.

In addition, the negative income effect associated with longer schooling occurred during a period when the income of active household members increased rapidly—by about 60 percent. Thus it is unlikely that overall income fell in households where a member became inactive. It simply increased slower than in other households. Such a relative and absolute income loss—and so the expansion of schooling in the bottom part of the distribution—would probably have been impossible without the general increase in labor productivity observed during this period. In other words, more inequality may have appeared through this channel because of the fast increase in the mean income of the population.

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[20] Of course, this fall did not actually happen because of the increase in the income of those household members who kept being active. It must also be stressed that this fall in income is the counterpart of an increase in the

The different effects of the expansion of education for men and women are shown in table 4. Here again there is a striking difference between these results and those for individual earners. The expansion of women's education is now unequalizing, while that of men is equalizing. The explanation is simple, and lies in the filtering due to labor force participation. The expansion of men's education is equalizing because their labor force participation is more or less uniform across the household income scale and, as seen for individual earners, their education gains are more important at the bottom of the distribution. For women the situation is different. Their participation is more often in the upper part of the distribution of household income, so the expansion of their education and the consequent rise in their earnings have a unequalizing effect that offsets the effect of a more equal distribution of schooling among the entire female population.

Family size and other population effects. Factors other than individual earnings are likely to influence the distribution of household income—especially the demographic composition of families. Putting into evidence the influence of that factor on the change in the distribution of household income is difficult because that evolution is clearly linked to economic and social phenomena that lie behind the price and occupational choice effects analyzed in preceding sections.

Things may be a bit simpler if attention is restricted to children under working age, who were considered exogenous in the household income model. The last rows of table 4 and figure 9 [**where is figure 9?**] report the results obtained with a simple simulation consisting of a rank-

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future income of children. Thus the unequalizing effect put into evidence here may be purely transitory.

preserving transformation of the distribution of the number of children in groups of households defined by the age, area of residence, and education of household heads. The transformation is of the same type as for education. The household in a given group with the most children in 1979 is given the number of children of the household with the most children in the same group in 1994. The same is then done for the household with the next largest number of children in that group, and so on for each group of households.

This approach unambiguously equalizes the distribution of equivalized household income. The Gini coefficient falls by an average of 0.8 percentage points (see table 4), and the average gain in net equivalized income falls as one moves up in the 1979 distribution (see figure 9). As for education, this overall effect includes the consequences of a change in participation behavior. Because there are fewer children to take care of, older household members modify their occupational choice, which modifies the household's income. This effect is extremely small, though (see table 4).

Other changes in the structure of the population may have had an important influence on the distribution of equivalized household income. Those changes can be measured by the residual of the effects of education and that of the number of children relative to the overall participation effect, which amounts to a 1.2 percentage point increase in the Gini coefficient. But these changes are harder to identify directly. Because they were practically negligible for individual earners and because the main difference in household composition has already been taken into account, it is tempting to relate them to the matching of individuals within households—for instance, the correlation between the earning potential of household members. The consequences of a change in this matching are analyzed in Fournier (1999) following the methodology in Burtless (1998 [**1999 in refs.**].

Conclusion

Using a decomposition analysis of inequality in Taiwan over 1979–94, this chapter offered explanations of the evolution of the income distribution among individual earners and households. It also offered evidence on the influence of some of the dramatic transformations that occurred in the structure of the population and the economy during that period.

Four phenomena were shown to be important in the evolution of the distribution of individual earnings:

- An increase in returns to education—which occurred despite dramatic growth in the supply of educated workers—contributed to higher inequality. But this effect was more than offset by the three following tendencies.
- A drop in the variance of the effect of unobserved determinants of individual earnings.
- A change in participation behavior that increased the weight of middle-income earners.
- The expansion of education, which equalized the distribution of schooling and so of earnings.

Together these four tendencies produced a significant drop in the inequality of individual earnings. Note, however, that there is some ambiguity about the interpretation of the second phenomenon. If we ignore that component, the change in participation behavior and the expansion of education more or less offset the unequalizing effect of the increase in returns to education.

The same four phenomena affected the evolution of the distribution of equivalized household income. But their effects were somewhat different, whether taken separately or jointly. In addition, other forces were present, so the overall outcome is rather different.

[**add "Household income"?**] Inequality unambiguously increased between 1979 and 1994. This was the result of the increase in returns to education and of the change in participation and occupational choice behavior—which turned out to be unequalizing at the household level instead of equalizing as for individual earners. This apparent contradiction is explained by the fact that net entrants in the labor force, mostly women, belonged to the upper part of the distribution of household income and the middle part of the distribution of individual earners. Taken together the effect of the higher returns to education and of the change in participation behavior may have been responsible for a 3.7 percentage point increase in the Gini coefficient of the distribution of household income.

This higher inequality was partly offset by the drop in the variance of the unobserved determinants of earnings. But unlike with individual earnings, no offsetting force came from the change in the population's education structure. A more equal distribution of schooling around a higher mean could have contributed to more equal household incomes, although to a lesser extent than for individual earners because of diversity within households. But this tendency was offset by the unequalizing effects of induced changes in participation, particularly the withdrawal from the labor force originating from longer schooling and higher enrollments.

Other potentially important influences on the distribution of household income include changes in the distribution of household size. Those changes contributed to more equality in the distribution of household income but were probably offset by other changes in the sociodemographic structure of households.

If one were to summarize that entire evolution and relate it to the economic trends in Taiwan during the period under analysis, the story suggested by the decomposition in this chapter could be as follows. Rapid economic growth increased the demand for educated labor—demand that went beyond the rapidly increasing supply resulting from the general expansion of education and of participation rates. As a result the returns to education rose, earnings differentials widened, and inequality increased among both individual earners and households. For individual earners this change was offset by a more equal distribution of schooling and by the fact that net entrants to the labor force were predominantly women at the middle of the earning scale. But for households those women contributed to higher inequality because they came from households in the upper half of the distribution. At the same time, longer schooling and its negative participation effect considerably dampened the equalizing potential of the expansion of education.

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[**It would be preferable to include the full first names or first two initials for all authors**]

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