TWO ESSAYS ON INCOME, CONSUMPTION AND RISK-SHARING IN TAIWAN

A Dissertation

Presented to

The Faculty of the Department

of Economics

University of Houston

In Partial Fulfillment

Of the Requirements for the Degree of

Doctor of Philosophy

By

Bin Gao

May, 2014

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Abstract

This study is devoted to the analysis of consumption-risk sharing and income inequality among Taiwanese households. In the first part of this study, I examine risk sharing during 1985–2006. I show that household-head income of low-education cohorts declined while those of higher education cohorts increased during 1997–2001; by comparison, both higher and low-education cohorts experienced similar growth in household-head income during 1985–1994 and 2002–2006. Therefore, I ask the question that whether these changes in relative growth in household-head income affected household consumption. Full risk sharing predicts that growth in household consumption should not be affected by idiosyncratic shocks to household-head income because the households could share risk through various channels such as transfers and the financial markets. Full risk sharing was rejected among Taiwanese households during 1985–2006. Nevertheless, more than sixty percent of the households' consumption risk was insured during this period. In addition, the level of risk sharing was higher during 1997–2001 when compared to that during 2002–2006. I decompose the risk-sharing channels into subperiods and find that a drop in the amount of risk-sharing achieved through income of household members was the main reason that risk-sharing during 2002–2006 was weaker than that during 1997–2001. In the second part of this study, I examine the changes in the individual and household-level income inequality. On the individual level, the difference in the average wage between male and female workers was shrinking during 1980–2011. In addition, the changes in the gender wage differences were more important than those in wage differences across education or age groups in explaining the changes in the individual-level inequality. On the household level, I show that household-income inequality was increasing in Taiwan in the late-1990s. Nevertheless, net private transfers and net cash benefits from social insurances lowered the household-level income inequality.

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Chapter 1

Consumption risk sharing under changing trends in household-head income: evidence from Taiwan

1.1 Introduction

How do changes in relative household-head income affect the relative consumption across cohorts of households? Full risk sharing implies that the growth of discounted marginal utility from consumption should not be affected by idiosyncratic income shocks. In other words, household consumption should respond only to aggregate shocks and not to individual-specific shocks under full risk sharing. In practice, the households can share their consumption risk through various channels, including income of household members, capital and credit markets, private transfers, unemployment and health insurance, and household savings and borrowing.

Income in Taiwan increased substantially among the working-age population during the economy's rapid growth through the 1980s and early 1990s. This boom in income was enjoyed by households from every education level. By comparison, there were different trends in household-head income during the late 1990s when low-education[1] households lost ground relative to their higher education counterparts.

[1]In this study, I define low-education cohorts to include households whose heads have junior high

Nevertheless, the growth in household-head income became more similar across cohorts after 2001. Thus, it is interesting to study how these different income trends affect the relative growth in household consumption. Observing different trends in household-head income in the United States during the 1980s, Attanasio and Davis (1996) show that household consumption was highly sensitive to the household-head income at the cohort level. In other words, there was little risk sharing across working-age cohorts.

There are few studies of household risk sharing on a macroeconomic scale in a developing country. Previous literature on risk sharing in developing countries carries out tests based on evidence from rural areas (Townsend (1994) and Zhang and Ogaki (2004)) or examines households' ability to insure their consumption against specific shocks such as illnesses (Gertler and Gruber (2002) and Genoni (2012)). The current study complements the literature by providing a macroeconomic view of risk sharing in the context of a fast-growing economy. In this study, I find that around one-third of consumption risk was not insured among Taiwanese households.

In addition, I examine the changes in risk sharing over time. This is interesting in the case of Taiwan because the latter transformed from a low-income economy to a high-income one. We might expect risk sharing to be affected by financial or other institutional changes or by changes in the labor market during this transition. Thus, I decompose the risk sharing into sub-periods. I find that risk sharing was stronger during 1997–2001, when compared to that during 2002–2006.

The main contribution of this study is to be the first, to the best of my knowledge, to examine the various channels of risk sharing across cohorts of households. I find income of household members, transfers, and household savings to be important channels of risk sharing. Meanwhile, the role of private transfers was slightly decreasing from 1985 to 1996, while public transfers was becoming more important. In addition, I find that risk sharing through income of household members nearly dropped by half from periods 1997–2001 to 2002–2006. This is the main reason that risk sharing

school education or less, because Taiwan has a nine-year compulsory education system.

during 2002–2006 was relatively weaker than that during 1997–2001.

Mace (1991) and Cochrane (1991) are among the first to test for risk sharing across households. Later contributions include Nelson (1994), Townsend (1994), Hayashi et al. (1996), Dynarski and Gruber (1997), Gervais and Klein (2010), and Mazzocco and Saini (2012), among others. Full consumption risk sharing is generally rejected at the household level. Cochrane (1991) finds that households are able to perfectly insure their consumption against transitory shocks such as temporary unemployment, but not against permanent shocks such as long-term illness. Other studies generally find that only a portion of consumption risk can be insured. A notable exception is Schulhofer-Wohl (2011), who finds that full risk sharing cannot be rejected with household heterogeneity in risk aversion and time preference. A concept closely related to risk sharing is consumption smoothing. Cochrane (1991) points out that while the permanent income hypothesis and life-cycle model predict that households should smooth their consumption across time, consumption risk sharing predicts that households should insure against cross-section consumption risk. In other words, full risk sharing allows all consumers to be affected by aggregate shocks, but not by idiosyncratic shocks. In the current study, I focus on the insurance of consumption across households rather than across time. That is to say, I study whether the households can smooth their consumption relative to others rather than across time.

While most previous studies on risk sharing across households focus on testing for full risk sharing, the current study focuses on how households share their consumption risk. Households could insure their consumption against the risk of household-head income through various channels. On the one hand, they could share the consumption risk against household-head income through within-household sources. For example, other household members could increase their labor supply to compensate for the decline in household-head income. Furthermore, households could reduce their current savings rate or draw on past savings to maintain consumption. On the other hand, households could share the consumption risk with other households. First, they could insure their consumption through private transfers by gifts or donations. Second, they could insure their consumption through social insurance and government subsidies. For example, unemployment insurance could provide relief in the case of job loss and health insurance could reduce the risk of catastrophic payments on health expenditure. Third, households could borrow in the credit market to smooth the intertemporal consumption. Finally, rental income and investment income from the capital market could hedge against the risk in household-head income if they are not perfectly correlated with the latter.

Therefore, it is important to study which of these channels are important in consumption insurance. Will households rely less on private transfers when other channels of risk sharing become more mature? How do savings or borrowing help households to insure against consumption risk? Asdrubali, Sørensen, and Yosha (henceforth ASY, 1996) decompose the channels of risk sharing for U.S. states. In this study, I follow their methodology to quantify the channels of risk sharing across cohorts of households.

To study risk sharing in Taiwan, I construct synthetic panel data by using cohorts of households. The most important advantage of cohort analysis is that the aggregation of individual households relieves the potential bias caused by idiosyncratic preference shocks. Individual preference shocks are difficult to observe and could cause omitted-variable bias if they are correlated with growth in individual income, as is articulated by Cochrane (1991). However, unobserved idiosyncratic preference shocks should be eliminated by aggregation if they are independent across households. Changes in family demographics can then be used as proxy for publicly observed life-cycle preference shifts.[2] Therefore, a test of full risk sharing based on cohorts rather than individual households should not be biased by omitted preference shocks. There are two other reasons I use cohort panel data. In addition, I am interested in decomposing the channels of risk sharing and this requires the use of

[2]It is important to control for preference shifts if they affect the marginal utility from consumption. The risk-sharing theory predicts that consumption marginal utility, and not consumption per se, should grow identically across households under full risk sharing. If preference shifts increase the marginal utility of some households, the consumption growth of these households would be larger even if full risk sharing is achieved. This notion is well articulated by Cochrane (1991).

panel data. However, there are no readily available longitudinal household-level data with high-quality information on both income and consumption expenditures in any country.[3] Furthermore, cohorts analysis allows me to observe the cohorts for multiple years. By comparison, risk-sharing studies based on individual households are limited to much shorter span of time. For example, households in the Consumer Expenditure Survey are observed up to four quarters. My strategy enables me to test that whether the level of risk sharing changes across years.

The rest of the paper is organized as follows. Section 2 proceeds in providing backgrounds on risk sharing and giving out testable models. Section 3 discusses the data. Section 4 reviews the evidence in relative income growth in Taiwan. Section 5 provides the main tests of risk sharing and examines the changes in risk sharing across years. Section 6 decomposes the risk-sharing channels and discusses the role of spousal employment, and Section 7 concludes.

1.2 Empirical specification

1.2.1 Model (Cochrane–Mace 1991)

The benchmark risk sharing model has been utilized in Cochrane (1991) and Mace (1991), among others. Full risk sharing is Pareto optimal and is feasible if the market is complete (i.e. households are able to trade any contingent claims which yield consumption units in certain future conditions). Suppose that a social planner maximizes the weighted sum of households' lifetime utilities:[4]

$$\max \sum_{i=1}^{N} \alpha_i E_0 U_i \tag{1.1}$$

where i indexes for households and E_0 denotes expectation at time 0. α_i is the Pareto weight of household i and is larger for the households who have relatively larger

[3] The recent development of Panel Study of Income Dynamics (PSID) might be an exception, which historically recorded mainly food expenditures.

[4] As is noted by Schulhofer-Wohl (2011), the social planner assumption is a convenient way to study optimal allocation, the study of which can also be decentralized.

lifetime endowments. Assume that there is a single consumption good and household consumption $c_{it}(s_t)$ is affected by state of the world s_t at time t. Therefore, expected lifetime utility E_0U_i can be expressed as

$$E_0U_i = \sum_{t=0}^{T} \beta_i^t \sum_{s_t} \pi(s_t)u(c_{it}(s_t), \delta_{it}(s_t)) \tag{1.2}$$

where time discount factor β_i can be household specific. $\pi(s_t)$ is the probability that state s_t occurs at time t and is the same across households. $\delta_{it}(s_t)$ represents the individual preference shift to household i in state s_t. Such preference shifts may contain unobserved taste shocks or observed preference changes such as giving births. Furthermore, assume that aggregate consumption cannot exceed aggregate endowment in any period and in any state:

$$\sum_i c_{it}(s_t) \leq \sum_i e_{it}(s_t) \tag{1.3}$$

where $e_{it}(s_t)$ is the endowment of household i at state s_t. Maximization of equation (1.2) subject to constraint equation (1.3) yields the following first-order equation for c_{it}:

$$\beta_i^t \alpha_i u_c(c_{it}, \delta_{it}) = \lambda_t \tag{1.4}$$

where $\lambda_t \equiv \mu(s_t)/\pi(s_t)$ is the Lagrange multiplier on the aggregate constraint divided by the probability of state s_t at time t. All s_t were omitted in equation (1.4) for clarity. β_i and α_i do not change across time and λ_t is the same across households at time t. Therefore, full risk sharing implies that consumption of each household responds only to aggregate shocks and not to idiosyncratic shocks. This prediction holds true for any utility function.

Assume that the households have Constant Relative Risk Aversion (CRRA) utilities with multiplicative exponential preference shocks δ_{it} (i.e. $u(c_{it}, \delta_{it}) = e^{\delta_{it}} c_{it}^{1-\gamma_i}/(1-\gamma_i)$). The preference shock is added in the exponential form so that utility does not become negative when δ_{it} takes negative values. Then, the first-order equation (1.4) leads to

$$\gamma_i \log(c_{it}^*) = \log \alpha_i + t \log \beta_i - \log \lambda_t + \delta_{it} + \epsilon_{it} \tag{1.5}$$

where c_{it}^* represents the observed consumption and ϵ_{it} represents the measurement error. Equation (1.5) shows that individuals with larger Pareto weight α_i will enjoy higher consumption in every period, holding other variables constant. A similar effect holds for more patient consumers (larger β_i) although this effect becomes larger over time because of the interaction between $\log \beta_i$ and time effect t. Moreover, more risk-averse (larger γ_i) consumers are predicted to have less consumption. Idiosyncratic preference shocks are captured by δ_{it}, which are allowed to vary across households and across time.

The main implication of (1.5) is that everyone should consume more when there are positive aggregate shocks and vice versa. This is reflected in the negative sign of normalized log-Lagrange multiplier $\log \lambda_t$. The Lagrange multiplier decreases when there are positive aggregate endowment shocks. Therefore, minus $\log \lambda_t$ increases when there are positive aggregate shocks, which boost consumption for every household.

Tests of risk sharing rely on the prediction from equation (1.5) that any exogenous idiosyncratic shocks should not affect individual consumption $\log(c_{it}^*)$. This result stems from the fact that individual shocks do not enter equation (1.5). Exogenous idiosyncratic shocks are fully insured under full risk sharing, and thus will not affect individual consumption paths. Although full risk sharing is usually rejected in empirical research (see Cochrane (1991) and Nelson (1994)), the extent of deviation from full risk sharing provides a useful measure of how much risk is not insured.

1.2.2 Implication for synthetic cohorts

In this section, I show the empirical model for synthetic panels, which is the empirical strategy used by Attanasio and Davis (1996). I categorize households into cohorts by education attainment and year-of-birth of the household heads. Analogous to the benchmark model for households, I assume that all cohorts are affected by an aggregate shock in each year. Suppose that household i belongs to cohort j (e.g. the cohort of households with a college-education head born from 1969 to 1971). Taking the sample average of equation (1.5) for households belonging to cohort j leads us to

$$\hat{\gamma}_j \overline{\log(c_{it}^*)} = \alpha_j + t\beta_j - \log \lambda_t + \delta_{jt} + \varepsilon_{jt} \tag{1.6}$$

where $\overline{\log(c_{it}^*)}$ is the sample mean of log household consumption in cohort j at time t: $\sum_{i=1}^{n(jt)} \log(c_{it}^*)/n(jt)$, and $n(jt)$ is the number of households belonging to cohort j at time t. $\hat{\gamma}_j$ is defined so as to satisfy the condition $\hat{\gamma}_j \overline{\log(c_{it}^*)} = \sum_{i=1}^{n(jt)} \gamma_i \log(c_{it}^*)/n(jt)$. The hypothetical $\hat{\gamma}_j$ is supposed to approximate for the level of general risk aversion in cohort j and is time invariant. α_j is the sample average of $\log \alpha_i$: $\alpha_j = \sum_{i=1}^{n(jt)} \log \alpha_i/n(jt)$. β_j, δ_{jt} and ε_{jt} are defined similarly. Note that ε_{jt} in equation (1.6) may also contain sampling errors of each sample average. I assume that sampling errors are independently distributed and not correlated with explanatory variables.

Finally, I assume that the coefficients of risk aversion $\hat{\gamma}_j$ and time preference β_j are identical across cohorts, while allowing the Pareto weights α_j to differ across cohorts and aggregate shocks $\log \lambda_t$ to vary across time. These assumptions are identical to those implicitly made by Attanasio and Weber (1996). Under these assumptions, equation (1.6) implies the following estimable equation:

$$\log C_{jt} = \phi_j + \tau_t + \theta \log X_{jt} + \psi F_{jt} + \varepsilon_{jt} \tag{1.7}$$

where $\log C_{jt} \equiv \overline{\log(c_{it}^*)}$ is the average of log household consumption in group j at time t, $\phi_j \equiv \alpha_j/\gamma$ denote cohort-fixed effects, and $\tau_t \equiv \gamma^{-1}(t\beta - \log \lambda_t)$ denote time-fixed effects. γ is homogeneous risk aversion (i.e. $\gamma \equiv \gamma_j = \gamma_k$ for any cohorts j and k). Similarly, β is homogeneous time preference. $\log X_{jt}$ represents the exogenous variable for cohort j, which does not appear in equation (1.6). In this study, X_{jt} refers to household-head income.[5] Once life-cycle factors are controlled for, X_{jt} should be

[5]Income include wages, pensions, welfare, bonuses, insurance sponsorship, agricultural income, self-employment income, and income from professional services. Operating income by entrepreneurs

exogenous because individual endogeneity should be averaged to zero by aggregation. F_{jt} includes household controls and is used as proxy for publicly observable cohort preference changes.

Interest centers on the coefficient θ, which is interpreted to be the percentage of unsmoothed consumption risk. By the argument of full risk sharing, estimated $\hat{\theta}$ should not be significantly different from zero. That is to say, $\hat{\theta}$ will be positive if risk sharing is not perfect, which means that cohort-specific earning shocks affect cohort consumption. The larger $\hat{\theta}$ is, the less risk is shared across cohorts and vice versa. Because there should be no omitted variables if the life-cycle demographic changes are valid proxies for preferences changes, OLS estimates of θ should be consistent.

In order to estimate equation (1.7), I use first differencing to remove the cohort-fixed effects. First differencing is especially interesting in this context because it has the direct interpretation of the response of the growth in consumption to the growth in household-head income because each variable is in the log form.[6] In addition, I demean each variable by the cross-section mean to remove the time-fixed effect. Therefore, equation (1.7) leads to the following equation:

$$\Delta\widetilde{\log C}_{jt} = \theta\Delta\widetilde{\log X}_{jt} + \psi\widetilde{\Delta F}_{jt} + \widetilde{\varepsilon}_{jt} \tag{1.8}$$

where $\Delta\widetilde{\log C}_{jt}$ is demeaned consumption growth rate of cohort j. Specifically, $\Delta\widetilde{\log C}_{jt} \equiv \Delta \log C_{jt} - \overline{\Delta \log C}_{.t}$, where $\overline{\Delta \log C}_{.t} \equiv N_t^{-1} \sum_j \Delta \log C_{jt}$ is the time t mean of consumption growth rate across all N_t cohorts. Other variables are defined in an analogous way.

In addition, I estimate how the degree of risk sharing evolves over time. Therefore, I estimate θ_P from the following equation:

$$\Delta\widetilde{\log C}_{jt} = \sum\nolimits_P \theta_P D_P \times \Delta\widetilde{\log X}_{jt} + \psi\widetilde{\Delta F}_{jt} + \widetilde{\varepsilon}_{jt} \tag{1.9}$$

are excluded.

[6]In a previous version of this paper, I directly estimate equation (1.7) using fixed effect, the main conclusions in this paper still hold in that case.

where D_P are time dummy variables which takes the value of one in specified periods and zero otherwise. All D_P dummies together constitute the whole period from 1985 to 2006. Thus, each θ_P represents the average amount of unsmoothed consumption risk in period P. A positive θ_P will reject full risk sharing in the relevant period.

1.3 Background of Taiwan and Data

1.3.1 Constructing synthetic panel data

For the purpose of this study, I use the Survey of Family Income and Expenditure (SFIE) from Taiwan.[7] SFIE is an annual survey of around 14,000 Taiwanese households and offers detailed information on incomes and expenditures. Samples are representative of the population and are drawn independently across years, thus enabling construction of synthetic panels.

SFIE began in 1964 and annual data are available from 1976. I use data from 1984 to 2006 because there is more consistent categorization of consumption expenditures during this period. Households are grouped into cohorts by heads' year-of-birth and education attainment. Birth cohorts are defined to be three-year bands and education cohorts are based on three levels of education attainments: junior high school or less, high school of equivalent and college or above. This design best fits the demographics in Taiwan and sample size.

In addition, I make the restriction that household-head ages do not exceed 55 and be at least 25 in any year, in order to minimize the effect of education and retirement.[8] Also, I restrict any cohort to stay in the sample for at least five years for the purpose of GLS estimation. As a result, my sample contains households born from 1933 to 1977.

Finally, I exclude households where either the head or spouse works in the military or as civil servants (see Chou et al. (2003)). I also exclude entrepreneurs, which

[7] SFIE has been used by previous authors for other purposes, including Deaton and Paxson (1994), Chou et al. (2003), McKenzie (2006), and Chen and Kuan (2013), among others.

[8] Cross section evidence shows that people usually begin to retire in their mid 50s because there is a drop in total household income but not a drop in income per earner around this time.

account for about 5% of the total population. Other sample restrictions are based on similar practices in the literature[9] and I exclude households with zero income, zero food expenditures, and others. In addition, I delete cohorts whose standard errors of estimated household-head income exceed the 95% percentile, while assuring that all cohorts are observed consequently across years. Table 1.1 shows cohort sizes by education cohorts and by sub-periods.

1.3.2 Consumption measures

The consumption measure I use includes nondurables and services. I exclude housing expenditure because the majority of households (around 80% and slightly rising over time) in the sample own houses and their housing expenditure is imputed rather than actually being paid. Health and education expenditures are also excluded because there are clear life-cycle patterns. Analysis by cohort shows that the households generally begin to increase spending on education from their early 30s, due to schooling of their children. The share of education expenditure in household disposable income reaches the peak in their mid 40s and then declines until reaching a trivial level after their age 50s. Health expenditure also exhibits clear life-cycle patterns. Households in their 30s tend to increase health expenditure, which is possibly related to maternity and their children. Finally, each consumption expenditure category is deflated by category-specific price index whenever possible.[10] Incomes and non-consumption expenditures are deflated by CPI.

Table 1.2 reports summary statistics. Average household-head income almost doubled from 1984 to 1994. The trend became stabilized after 1995, but it masked the differences across higher and low-education cohorts. Income of household members were increasing in both periods. Interestingly, income from other sources (rental income, net transfers and insurance income) was increasing after 1995 when the overall household-head income were staggering. The growth rate of nondurable expenditures

[9] For example, see Hayashi et al. (1996), Krueger and Perri (2006) and Gervais and Klein (2010).

[10] Category-level price indexes are not available for a few consumption expenditures, and I use CPI to deflate these categories.

was less than that in household-head income before 1995, but exceeded the latter after 1995.

1.4 Relative income' growth trends

This section shows relative trends in household-head income, which are treated as being exogenous. Results are organized by education and birth cohorts in order to keep accordance with design of the synthetic panel.

Table 1.3 shows differences in logarithms of real household-head income across cohorts and across years. Each cell in the table represents a cohort observed in one year. Panel A shows data for years from 1996 to 2006 and for cohorts born from 1948 to 1974.[11] The entry in each cell is the difference between average log household-head income of the corresponding cohort-year and that of the base cohort-year. The base cohort-year is chosen to be the cohort born from 1969 to 1971 with high school education observed in 1996. Thus, the entry is 0 by definition for the base. Other entries show the log difference against the base. Because all entries in panel A have the same base, comparison is possible both within and between education cohorts.

A significant pattern is that households in the low-education cohorts lost ground to those with in the higher education cohorts from 1996 to 2001. In fact, low-education cohorts generally experienced a decline in real household-head income during this period. For example, the 1960–1962 cohort with junior high school education experienced a decline in household-head income by 10% from 1996 to 2001. On the contrary, higher education cohorts generally experienced an increase in household-head income from 1996 to 2001. The increase in income was stronger for younger cohorts. For example, average household-head income increased by 28% for cohort 1969–1971 from 1996 to 2001; and the increase for cohort 1960–1962 was 5% during the same period. As a result of the different trends in household-head income between higher and low-education cohorts, the disparity between the two groups increased for nearly all birth

[11]Note that a broader range of cohorts, born from 1942 to 1977, will be used in estimation. Only cohorts observed more than six years are shown in table 1.3.

cohorts. For households born from 1969 to 1971, the higher education cohort was earning 15% more than the low-education cohort in 1996. This disparity increased to 62% in 2001. Similar patterns are observed for other birth cohorts, while the younger cohorts experienced larger increases in income disparity.

Nevertheless, the trends in household-head income became more similar after 2001. On the one hand, low-education cohorts experienced similar growth in income with higher education cohorts among young households. For example, household-head income increased by 3% from 2001 to 2006 for cohort 1969–1971 with junior high school education; that of higher education households in the same birth cohort increased by 8% during this period. On the other hand, both higher and low-education cohorts born before 1960 experienced similar declines in household-head income.

Panel B of Table 1.3 is constructed analogously to panel A for years from 1984 to 1994 and for cohorts born between 1936 and 1962. The base is set to be cohort 1957-1959 with high school education observed in 1984. Growth in income was much larger during this period. Nevertheless, trends of income appeared relatively more similar across higher and low-education cohorts. For example, average household-head income of the low-education cohort born from 1957 to 1959 grew by 107% from 1984 to 1994; income of the high school education cohort born in the same years grew by 114%; and that of the college-education cohort grew by 141%. As a result, disparity in income increased by less across higher and low-education cohorts than that after 1996. For example, households in the higher education cohort born 1957–1959 were earning 32% more than did households in the low-education cohort in 1984. This disparity increased to 40% in 1989. This change is modest compared to what happened to cohort 1969–1971 during years from 1996 to 2001, who were in the same age range.

Consumption exhibits more similar trends across higher and low-education cohorts, as can be seen in Table 1.4. Specifically, low-education cohorts still experienced consumption growth after 1996. Although consumption of low-education cohorts was certainly lower than that of higher education cohorts, consumption growth was rather similar across higher and low-education cohorts from 1996 to 2006. By comparison, higher education cohorts generally experienced larger growth in consumption from 1984 to 1994. Therefore, evidence suggests some changes in risk sharing.

1.5 Testing for full risk sharing

The previous section shows that the disparity of income growth increased sharply across cohorts from 1996 to 2001. By comparison, the disparity increased to a lesser extent before 1994 and after 2001. Thus, this section tests for full risk sharing over the period 1985–2006, and estimates the levels of risk sharing in each sub-period to examine whether the risk sharing changes over time.

1.5.1 Benchmark specification

I estimate equation $\Delta\widetilde{\log C}_{jt} = \theta\Delta\widetilde{\log X}_{jt} + \psi\widetilde{\Delta F}_{jt} + \widetilde{\varepsilon}_{jt}$ (equation (1.8)) to test for full risk sharing. The dependent variable is the idiosyncratic growth in cohort average consumption, and the independent variable is similarly defined growth in household-head income. Under full risk sharing, θ would be zero, meaning that relative growth in household-head income would not affect relative growth in consumption.

Shocks to average household-head income are arguably exogenous for two reasons. First, idiosyncratic preference shocks are averaged to zero within the cohorts, thus preventing the bias caused by unobserved individual preference shocks. Second, I focus on prime age households to minimize the endogeneity relating to household-head labor supply. Specifically, I assume that household heads in the prime age have little elasticity[12] in labor supply. Thus, household-head income in my sample are unlikely to be decision variables which would be correlated with preferences or other endogenous variables.

Furthermore, I use household-head income, instead of household disposable in-

[12]Indeed, in the 2006 sample, there are 6,113 households with a head aged between 35 and 55 (which are used to construct cohorts). Among them, only 74 household heads were unemployed when interviewed.

come, as the exogenous variable. The reason is that other components of household income include measures of insurance. For example, there may be no spouse at some households. In that case, there would be no consumption insurance provided by a spouse. Because I measure consumption risk sharing across the whole working-age population, I use household-head income so that households both with and without a spouse are comparable. Income are largely determined by labor supply, and generally do not include elements of insurance. Therefore, I use changes in household-head income as the exogenous shocks in equation (1.9).

As for ΔF_{jt} in equation (1.9), I use changes in household controls as proxy for publicly observable preference changes.[13] Specifically, I use the average number of adults, the average number of children under and over age 5, and the average number of elderly as cohort-level household controls. Finally, regressions are weighted by squared cohort size, and I allow for heteroscedasticity and cohort specific serial correlation in the error terms in the demeaned equations (1.8) and (1.9).

1.5.2 Benchmark result

Table 1.5 reports results of the tests for full risk sharing during the period 1985–2006. Cohorts are defined by heads' education and year-of-birth[14] in the benchmark specification, or by heads' year-of-birth only. The birth cohorts are constructed by averaging the households over all education levels within the same birth cohorts.

The hypothesis of full risk sharing ($\theta = 0$) is soundly rejected for the whole period. In the benchmark specification, around 36% of consumption risk was not smoothed. The result is robust to the inclusion of household controls. In addition, there was a similar amount of unsmoothed consumption risk across birth cohorts during the whole period. Therefore, the result in Table 1.5 shows that full risk sharing was not achieved throughout the period. Nevertheless, we might expect that the risk sharing

[13]Household compositions are intuitively important in explaining life-cycle behaviors. See Fernandez-Villaverde and Krueger (2007) for an example of the effect of household size on life-cycle consumption.

[14]Estimation based on cohorts defined by education only will indicate similar conclusions. I do not report the results here because of the relative small sample size.

to change over time. There may be full risk sharing during some sub-periods. In that case, full risk sharing will still be rejected for the whole period if there are low levels of risk sharing in other sub-periods.

1.5.3 Risk sharing across years

In order to separate risk sharing in different times, I estimate equation $\Delta\widetilde{\log C}_{jt} = \sum_P \theta_P D_P \times \Delta\widetilde{\log X}_{jt} + \psi\widetilde{\Delta F}_{jt} + \widetilde{\varepsilon}_{jt}$ (equation (1.9)). D_P are dummies for the following periods: 1985–1989, 1990–1994, 1995–1996, 1997–2001 and 2002–2006. Each period spans over five years, except the period 1995-1996. I separate these two years in order to minimize the influence of National Health Insurance (NHI), which was inaugurated in Taiwan in March 1995. NHI was a mandatory health insurance plan available to every legal resident of Taiwan. NHI increased the insured fraction of the population from 57% in 1994 to 97% in 1998, most of whom came from unemployed houseworkers, children and elderly (Chou et al. (2003)).

NHI could influence risk sharing in both positive and negative ways. On the one hand, NHI is likely to decrease risk sharing by reducing savings. Kuan and Chen (2013) find that NHI reduced household savings, especially among high- income households. In that case, consumption of high-income household would grow by more (or decrease by less) than that of low-income households. Therefore, growth in consumption would be more dispersed than if NHI were not in place. Thus risk sharing would decrease. On the other hand, NHI could have possibly increased the importance of public transfers. Payments from NHI, together with government- and-employer sponsored NHI premiums, are counted as income from social insurance in SFIE. If cohorts with declining household-head income receive relatively more income from NHI, then risk sharing through public transfers would increase. For these two reasons, I treat years 1995 and 1996 as a separate period.

Table 1.6 shows the levels of unsmoothed consumption risk for different sub-periods from 1985 to 2006. The values in the table correspond to the estimated θ_P in equation (1.9) for each period P. Smaller values indicate less unsmoothed risk, because idiosyncratic consumption changes would be less sensitive to income shocks. Therefore, a smaller value of θ implies stronger risk sharing.

Columns (1) and (2) of Table 1.6 show estimates under the benchmark specification, which is based on full population decomposition by education attainment and year-of-birth. Full risk sharing is rejected in all sub-periods. In the specification without household controls, around 40% of consumption risks were not insured in all periods except the period 1997-2001. In fact, only 23% of consumption risk was unsmoothed during this period. By comparison, the unsmoothed portion of consumption risk during the period 2002–2006 is 42%, and is significantly higher than that during the period 1997–2001 at a statistical confidence level of 1%. Moreover, this inequality holds when household controls are included in the regression. In sum, the benchmark specification shows that there was stronger risk sharing during the period 1997–2001 than that during 2002–2006.

Columns (3) and (4) in table 1.6 explore patterns of risk sharing across birth cohorts. Unlike the benchmark specification, there is a general trend of decreasing risk sharing across birth cohorts, as the portion of unsmoothed consumption risk increased over time. In the specification without household controls, the percentage of unsmoothed consumption risk increased from 20% during 1985–1989 to 57% during 2002–2006. This change is significant both statistically and economically. The specification with household controls yields a similar result. Thus, risk sharing was weakening across birth cohorts in Taiwan.

1.6 Channels of risk sharing

1.6.1 Specification

The previous section shows that the risk sharing was stronger during 1997–2001 than that in subsequent years. This section decomposes the channels of risk sharing to examine the reasons for this difference. There are various channels for consumption risk sharing (or consumption insurance). First, household members, if at present and if they have income, could provide consumption insurance when the head faces declining income. This could happen if income of household members do not drop as much as that in household-head income, relative to income of members from other households. Similarly, capital and credit markets could provide consumption insurance through interest incomes, dividends, rental incomes and other property income. Consumption insurance could also be achieved through private and public transfers, where public transfers include government transfers and social insurance.[15]

Savings is another important channel for consumption risk sharing. Consumption insurance can be achieved if the households increase savings in good times and dissave in bad ones.[16] Also, households could borrow in the credit market as a way of dissaving. In both cases, household consumption will be less sensitive to changes in household-head income. I follow ASY (1996) to explore the channels of risk sharing by a method of variance decomposition. The following equations outline the framework:

$$\begin{aligned}
\Delta \log HE_{jt} - \Delta \log TE_{jt} &= \eta_t^F + \beta^F \Delta \log HE_{jt} + \upsilon_{jt}^F \\
\Delta \log TE_{jt} - \Delta \log NK_{jt} &= \eta_t^K + \beta^K \Delta \log HE_{jt} + \upsilon_{jt}^K \\
\Delta \log NK_{jt} - \Delta \log NP_{jt} &= \eta_t^P + \beta^P \Delta \log HE_{jt} + \upsilon_{jt}^P \\
\Delta \log NP_{jt} - \Delta \log NT_{jt} &= \eta_t^T + \beta^T \Delta \log HE_{jt} + \upsilon_{jt}^T \\
\Delta \log NT_{jt} - \Delta \log TC_{jt} &= \eta_t^S + \beta^S \Delta \log HE_{jt} + \upsilon_{jt}^S \\
\Delta \log TC_{jt} &= \eta_t^U + \theta^U \Delta \log HE_{jt} + \upsilon_{jt}^U
\end{aligned} \tag{1.10}$$

where HE denotes household-head income. $\Delta \log HE_{jt}$ is the change in average log heads' income of cohort j from year $t-1$ to year t. Other variables in log differences are defined analogously. In addition, TE stands for total household income (i.e. household-head income plus income of household members), NK for total household

[15] Young and retired households may depend more on transfers and social insurance to smooth consumption. Because I exclude these households, the estimates in this section should be interpreted as the effect of public transfers and insurance on working-age households.

[16] Technically, household saving rate should be positively correlated with growth rate in disposable income across households when there is positive risk sharing.

income plus net interest and property income, NP for NK plus net private transfers, NT for NP plus net public transfers (public transfer income minus taxes), and TC denotes total household consumption expenditures. Derivation of this decomposition can be found in ASY (1996).

The coefficients β in equations (1.10) have interpretations of how much consumption risk is smoothed or amplified through each channel. Positive values indicate that the corresponding channel provides consumption insurance. Specifically, β^F measures the amount of risk smoothed through household members, β^K measures the amount smoothed through capital and credit markets, and so forth. θ^U measures the amount of unsmoothed consumption risk. By construction, all β and θ^U in equation (1.10) sum up to one. As the values of β increase, the unsmoothed portion will decrease. Upon full risk sharing, θ^U would be zero.

Take β^F for example. When household-head income decrease, the coefficient would be positive if total household income decrease less than do heads' income, on the condition that members from other households have identical income' growth rates with their heads. This requires that income of household members, if any, decrease by a less percentage. If members' income drop by a larger percentage than does heads' income, then β^F would be negative. In that case, household members would provide negative insurance. Moreover, the coefficient would be one if members' income increase large enough to compensate entirely for the drop in their heads' income and for the differences in wage growth of other heads. By a similar argument, members could provide excess insurance if the coefficient is larger than one.

The above arguments are based on the condition that growth in income is identical between heads and their members in other households. If, instead, household members in high-income households experience declining income, there could still be positive risk sharing if members in low-income households do not experience changes in income. In sum, risk sharing is positive if household income are not perfectly correlated with heads' income across households. On the contrary, there would also be zero insurance if growth in members' income are perfectly correlated with heads' income.

In addition, if there are no household members or other members do not have income, then household income will be perfectly correlated with heads' income. In that case, insurance provided by family members would be zero (i.e. $\beta^F = 0$).

Similar arguments could be made for the channels through capital and credit markets, private transfers, and public transfers.[17] Each channel will provide insurance if including them would make growth in households' income become relatively less correlated with growth in heads' income. The channel through savings is different from the above channels in the way that it actually incorporates two kinds of consumption insurance: household savings and borrowing from other savers.[18] Also note that consumption smoothing provided by credit market mentioned above refers exclusively to contributions of net interest income. Thus, the effect of credit market on consumption insurance may be incorporated both in θ^K and θ^S.

Finally, θ^U measures the unsmoothed consumption risk. By definition, the unsmoothed risk is the sensitivity of household consumption expenditure to idiosyncratic changes in household-head income. Consumption here refers to all expenditures. Thus, θ^U differs from that in previous sections such as equation (1.8), because the consumption measure in the latter includes only nondurables and services.[19] The larger θ_U is, the more sensitive consumption would be to idiosyncratic changes in household-head income, and thus the less consumption insurance among specified cohorts of households.

It might be a good proposition that the risk smoothed through each channel varies over time, because of varying economic conditions and institutional changes. For example, the amount of risk smoothed through household members depends on members' ability to hedge against risks in heads' income. If it becomes even more difficult for household members to maintain or increase labor supply when household-

[17] I exclude households whose income at either level becomes negative. Nevertheless they represent a tiny fraction of the population.

[18] This paper does not distinguish between household savings and borrowing because loans made at the current period are not reported in SFIE.

[19] I can separate durable goods in equation (1.10) and define durable goods, health and education together to be a channel. In that case, the estimated unsmoothed consumption risk would be nearly identical to previous estimates such as those in table 1.5.

head income decline, then the risk smoothed through this channel would likely to decrease. Institutional changes may also affect risk sharing. For example, newly inaugurated insurance schemes may provide income to households who had no such incomes before, and thus increasing risk sharing through public transfers. Therefore, I estimate the following equations to quantify the channels of risk sharing at different times:

$$\begin{aligned}
\Delta \log HE_{jt} - \Delta \log TE_{jt} &= \eta_t^F + \sum\nolimits_P \beta_P^F D_P \times \Delta \log HE_{jt} + \upsilon_{jt}^F \\
\Delta \log TE_{jt} - \Delta \log NK_{jt} &= \eta_t^K + \sum\nolimits_P \beta_P^K D_P \times \Delta \log HE_{jt} + \upsilon_{jt}^K \\
\Delta \log NK_{jt} - \Delta \log NP_{jt} &= \eta_t^P + \sum\nolimits_P \beta_P^P D_P \times \Delta \log HE_{jt} + \upsilon_{jt}^P \\
\Delta \log NP_{jt} - \Delta \log NT_{jt} &= \eta_t^T + \sum\nolimits_P \beta_P^T D_P \times \Delta \log HE_{jt} + \upsilon_{jt}^T \\
\Delta \log NT_{jt} - \Delta \log TC_{jt} &= \eta_t^S + \sum\nolimits_P \beta_P^S D_P \times \Delta \log HE_{jt} + \upsilon_{jt}^S \\
\Delta \log TC_{jt} &= \eta_t^U + \sum\nolimits_P \theta_P^U D_P \times \Delta \log HE_{jt} + \upsilon_{jt}^U
\end{aligned} \tag{1.11}$$

where D_P are time dummies for the following periods: 1985–1989, 1990–1994, 1995–1996, 1997–2001 and 2002–2007. Each D_P takes the value of one in the specified period and zero otherwise. Other variables are defined in the same way as in equations (1.10). Thus, each β_P has the interpretation of the amount of risk sharing achieved through a specific channel during period P. For example, $\beta_{1985-1989}^F$ represents the amount of risk sharing achieved through income of household members during the period 1985–1989; $\beta_{1990-1994}^F$ is the amount achieved through household members during the period 1990–1994, and so forth. I use equations (1.11) to capture the time-varying risk sharing through each channel.

1.6.2 Results for risk-sharing channels

As a first step, I show the risk sharing through each channel over the whole period from 1985 to 2006. I estimate equations (1.10) and Table 1.7 reports the results. In the benchmark specification with birth and education cohorts, 32% of consumption risk was smoothed through household members; a cumulative 19% of risk was smoothed through capital and credit markets, and public and private transfers; 11% of risk was smoothed through household savings or borrowing; and the remaining 38% of consumption risk was unsmoothed.

The right column in Table 1.7 shows the risk sharing across birth cohorts. The amounts of risk sharing achieved through financial markets and transfers were similar to those in the benchmark specification. Nevertheless, more consumption risk (41%) was smoothed through household members across birth cohorts. This is an expected result because households of all education levels are averaged within the same birth cohort. In other words, household members are more likely to smooth the risk in their heads' income across age cohorts than across education cohorts. By comparison, risk sharing achieved through savings is not significantly different from zero. It means that if heads' income cause relative changes in household disposable income, then relative household consumption will change to the same extent. That is to say, household savings does not smooth total consumption from changes in household disposable income if we look across birth cohorts.

Table 1.8 shows the amounts of risk sharing achieved through each channel in different sub-periods, together with the amounts of unsmoothed consumption risk. I focus on the benchmark specification where cohorts are defined by heads' education and year-of-birth because it provides a larger sample. The coefficients are estimated from equations (1.11) with GLS estimation. The table confirms that the amount of unsmoothed risk was lower during 1997–2001, especially when compared with that during 2002–2006.

In addition, the main reason for the rebound in unsmoothed risk after 2002 is the reduced risk sharing through income of household members. The amount of unsmoothed consumption risk increased from 25% during 1997–2001 to 46% during 2002–2006. Meanwhile, the amount of consumption risk smoothed through household members declined from 36% to 20%. Risk sharing through capital and credit markets also declined. Specifically, net interest and property incomes smoothed 6%

of consumption risk from 1997 to 2001, but the same quantity became insignificant from zero after 2002. Although the amount of risk smoothed through public transfers increased from 9% to 13%, it did little to compensate for the decrease in consumption risk smoothed through other channels. In summary, declining risk sharing through income of household members is the main reason that risk sharing weakened after 2002.

Table 1.8 also reveals the risk sharing through other channels and their trends over time. The role of financial markets seems to be volatile. Capital and credit markets provided significant consumption insurance during the periods 1990–1994 and 1997–2001, but not in other years. Positive risk sharing through capital and credit markets indicates that the growth in net property income was relatively stronger for low-education households. In fact, the average annual growth rate of interest income was 28% for low-education cohorts during 1990–1994, while the average growth rate in interest expenditure was 48%. These numbers were 12% and 67% for higher education cohorts during the same period. Moreover, there was barely growth in real interest income for low-education cohorts from 1997 to 2001, and real interest expenditure decreased by an average of 6% annually. During the same period, real interest expenditure grew by around 9% per year for higher education cohorts. Therefore, smoothing provided by net interest and property income seems to be caused mainly by larger interest expenditure by higher education cohorts. That is to say, higher education cohorts engaged relatively more in borrowing from the credit market.

Net private transfers provided positive insurance in most sub-periods during 1985–2006, although its importance was declining. About 12% of consumption risk was smoothed through private transfers in the latter half of the 1980s, yet only 8% was smoothed during the period 2002–2006. By comparison, public transfers became more important[20], especially after 1995 and this is possibly due to NHI. Around 13% of consumption risk was smoothed through public transfers in 1995 and 1996, and an

[20]However, the survey did not record incomes from labor insurance, government employee insurance and farmers insurance before 1992. Thus the amount of consumption smoothing achieved through public transfers may be underestimated in earlier years.

identical proportion was smoothed through public transfers after 2002.

Finally, household savings seem to become an important channel for consumption insurance after 1990. Before 1990, little consumption risk was smoothed through savings. That is to say, growth rates in both household disposable income and household consumption are correlated with growth in household-head income to the same extent during this period. In addition, the channel through savings again become insignificant during years 1995 and 1996. This is consistent with the evidence that high-income households reduce savings by a larger extent after NHI was inaugurated.

1.6.3 Discussion on spousal employment

The previous section finds that income of household members is important in explaining the stronger risk sharing during the period 1997–2001 than that during 2002–2006. Therefore, I examine the changes in spousal employment in this section. Because the degree of risk sharing in each period is actually the weighted average across years, I will show the correlation between risk sharing and spousal employment on a yearly basis. From equations (1.10), the consumption risk smoothed through income of household members in each year y can be expressed as

$$\beta_y^F = \frac{\mathrm{Cov}(\Delta \log HE_{jy} - \Delta \log TE_{jy}, \Delta \log HE_{jy})}{\mathrm{Var}(\Delta \log HE_{jy})} \equiv 1 - \frac{\mathrm{Cov}(\Delta \log TE_{jy}, \Delta \log HE_{jy})}{\mathrm{Var}(\Delta \log HE_{jy})} \tag{1.12}$$

where HE and TE represent heads' income and household income, respectively. Covariance and variance are both taken across cohorts in each year. The implication of equation (1.12) is that the amount of risk sharing provided by household members depends on the relative strength of members' income against that of the household head. If growth rates in heads' income become more unequal, then β_y^F would increase if the covariance between the growth in total household income and that in heads' income increases to a lesser extent. This requires that relative changes in household members' income are strong enough to offset the increasing dispersion in heads' income. In practice, income should increase relatively more for household members who have a head with relatively declining income.

Therefore, I focus on spousal employment rate[21] and look at its correlation with risk sharing. I define spousal employment rate to be the percentage of households with a working spouse. Thus, households with no spousal labor supply include those without a spouse at present, as well as the households where the spouse is not working. For the purpose of this study, it is unnecessary to distinguish these two kinds of households because there would be no insurance provided by spouses in either case.

Figure 1.1 shows the correlation between spousal employment rate (the dashed line) and the unsmoothed consumption risk (the solid line). Specifically, the solid line corresponds to $\frac{\text{Cov}(\Delta \log TE_{jy}, \Delta \log HE_{jy})}{\text{Var}(\Delta \log HE_{jy})}$ in equation (1.12), and is interpreted as the residual unsmoothed risk after accounting for household members' income. In addition, spousal employment rate is represented by the right vertical axis. It can be seen that the unsmoothed consumption risk was negatively correlated with spousal employment rate from 1985 to 2006, and the correlation is $-.40$ during this period. Moreover, the increasing amount of unsmoothed consumption risk during years 2002 and 2003 is associated with decreasing spousal employment rate. Actually, the unsmoothed risk became temporarily larger than one in 2003, which means that there was negative insurance provided by household members in 2003. That is to say, income of household members dropped relatively more than income of their heads in 2003. Although there was no decrease in spousal employment rate in 2006, the unsmoothed risk still increased because of reduced dispersion in household-head income. In that case, income of household members were not changing enough to reduce the correlation between household income and heads' income.

On the contrary, there was relatively less unsmoothed consumption risk during the period 1998–2001, at a time when there were larger increases in dispersion in heads' income. In fact, variance of growth rate in heads' income more than tripled during

[21] Other income earners, such as children and siblings, could also provide consumption insurance against risks in heads' income. Nevertheless, employment of other members does not help to explain the changes in risk sharing as the correlation is close to zero.

this period. Although spousal employment rate did not increase significantly during 1997 and 2001, it temporarily withstood the declining trend beginning in 1994.[22] As a result, the unsmoothed risk remained at a relatively low level. In other words, spousal employment rate and income were stable enough during this period to offset the increasing dispersion in heads' income. As a result, the degree of risk sharing was stronger during the period 1997–2001 than that during 2002–2006.

1.7 Conclusion

This study examined the effects of changes in household-head income on household consumption. Taiwanese households experienced different income growth across education and birth cohorts in the late 1990s: household-head income of low-education cohorts decreased but that of higher education cohorts increased. By contrast, before 1995 and after 2002, these trends were relatively homogeneous. Thus, this study examined whether household consumption was insured against the relatively increasing dispersion of heads' income in the late 1990s.

The motivation and framework of this analysis are based on the theory of consumption risk sharing. Under plausible assumptions, full risk sharing implies that household consumption should respond only to aggregate shocks, and not to idiosyncratic income shocks. Therefore, full risk sharing predicts that consumption growth trends should not diverge given divergent trends in income of household heads. Therefore, this study tested whether there was full risk sharing in Taiwan.

To address my research question, I constructed panels of cohorts by aggregating household-level data, an attractive strategy because it prevented possible omitted-variable bias caused by unobserved individual preference shocks. In addition, I focused on prime-age households in each year. Thus, my sample was representative of the working population in Taiwan and did not contain life-cycle or cohort effects.

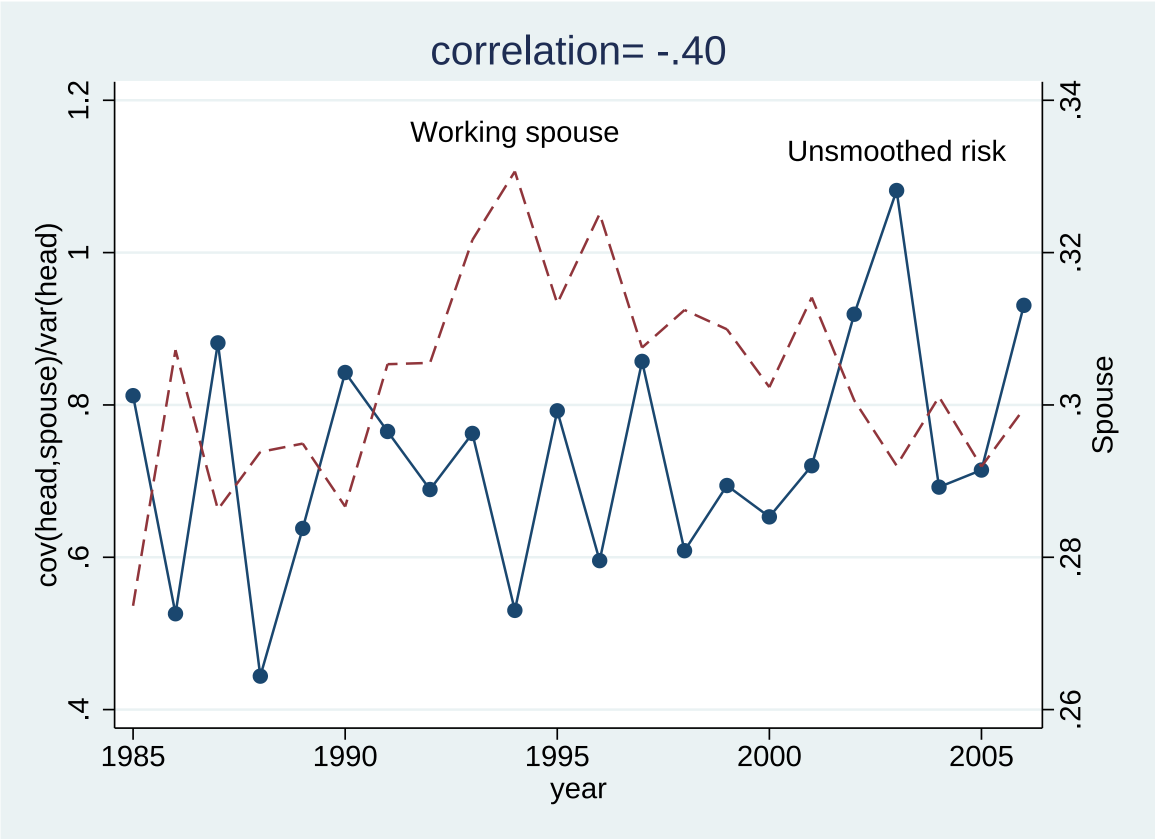
[22]The reason for the decline in spousal employment rate in Taiwan is out of scope of this paper. Nevertheless, crude evidence shows that household size has been gradually declining throughout the study period, falling from an average of 4.90 persons per household in 1985 to 3.77 in 2006, as can be seen in table 1.2. In addition, the percentage of married household heads during ages 25 and 55 fell from 84% in 1985 to 67% in 2006.

This study rejected full risk sharing among Taiwanese households during the period 1985–2006. I found that, on average, one-third of consumption risk was not insured during this period. Nevertheless, there was stronger risk sharing in Taiwan during the sub-period 1997-2001. In fact, around 27% of idiosyncratic changes in household-head income was not insured from 1997 to 2001. By comparison, 46% of income shocks was unsmoothed during the period 2002–2006.

In order to explore the reasons for this difference in the degree of risk sharing, I decomposed risk-sharing channels using a method of variance decomposition proposed by ASY (2006). This method allowed me to quantify the amount of consumption risk achieved through each channel. I found that the channel of income from household members is important in explaining the relatively stronger degree of risk sharing during the period 1997–2001. Specifically, income of household members helped insure 36% of consumption risk against household-head income during 1997–2001. By comparison, this amount decreased to 20% during the period 2002–2006.

In addition, I looked at spousal employment. I define spousal employment rate to be the percentage of households with a working spouse within each cohort. Spousal employment rate remained at a relatively constant level at 31% from 1997 to 2001, when the variance of growth rates in household-head income increased substantially. At the same time, unsmoothed consumption risk stayed at a relatively low level. This implies that growth in household income was relatively less correlated with growth in household-head income, because of the offsetting role of income by household members. By comparison, spousal employment rate dropped from 31.4% in 2001 to 29.2% in 2003. Meanwhile, there was decreasing dispersion of growth in household-head income. As a result, income of household members barely provided consumption insurance in these two years. In sum, the stabilized spousal employment rate accompanied strong risk sharing through income of household members during the period 1997–2001, and decreasing spousal employment rate was correlated with relatively weaker risk sharing in years 2002 and 2003.

Figure 1.1: Risk Sharing and Spousal Employment Rate



Note: The solid line represents unsmoothed risk, and is defined as normalized covariance between the growth in household income and that in household-head income. Household income include both household head's and members' income. The dashed line represents spousal employment rate, and is defined as the percentage of households with a working spouse within each cohort. Cohorts are defined by three-year bands of household head's year-of-birth, crossed by three levels of education attainment.

Table 1.1: Cohort Sizes from SFIE Data

Groups	No. of obs	Mean	Min	Max	t=1	t=6	t=11
1996–2006							
Junior high	102	323	53	607	395	310	287
High school	98	297	100	428	288	293	299
College	98	225	82	330	190	218	267
1984–1995							
Junior high	114	632	145	954	732	683	540
High school	107	278	51	528	256	271	326
College	90	182	46	328	151	179	211

Note: t indexes for year, and the corresponding value is the average cohort size in the relevant education group at year t. Households with a head aged between 25 and 55 are selected into sample in each year. Cohorts are defined by three-year bands of household head's year-of-birth, crossed by three levels of education attainment. Cohorts with a standard error larger than the 95% percentile in the estimation of household-head income are dropped from sample, while ensuring that any cohort is observed consequently across years. Data are from Survey of Family Income and Expenditure of Taiwan, and calculation made by the author.

Table 1.2: Summary Statistics

Category	1984	1989	1996	2001	2006
Incomes					
Head's income	11,325	16,076	21,122	21,179	21,146
Members' income	3,861	5,727	8,597	8,634	8,857
Disposable income	14,665	20,934	28,507	29,061	29,964
Housing income	998	1,155	2,305	2,495	2,266
Expenditures					
Nondurables	9,243	11,252	14,486	14,993	15,323
Health	769	919	2,415	2,770	3,422
Education	801	1,078	1,490	1,601	1,780
Durable	306	583	869	778	797
Net savings	3,545	7,103	9,248	8,917	8,642
Housing expenditures	1,943	2,737	4,131	4,343	4,497
Demographics					
Adults	2.40	2.32	2.28	2.23	2.20
Children under 5	0.70	0.50	0.40	0.33	0.23
Children over 5	1.48	1.39	1.19	1.02	0.93
Elderly	0.23	0.24	0.30	0.31	0.35
Household size	4.98	4.57	4.27	3.96	3.77
Working spouse	0.27	0.29	0.33	0.31	0.30

Note: All numbers are averaged across households with a head aged between 25 and 55 in each year. Monetary values are based on 2011 prices, and are converted to U.S. dollars by the average exchange rate of (1 USD= 31 TWD) over years 1984–2006, where TWD denotes the currency in Taiwan. Income include wages, pensions, self-employment income, and welfare. Housing income has been imputed. Net saving is defined to be household disposable income minus total expenditures. Housing expenditures include both rent and imputed housing expenditures. Housing income and expenditures are not included in the calculation of disposable income and savings. Adults are defined to include all household members over the age of 18, excluding students. Children over age 5 include children under age 17 and student dependents under age 22. Data are from Survey of Family Income and Expenditure of Taiwan and calculations made by the author.

Table 1.3: Relative Changes in Household-head Income

A: 1996–2006									
Year	1972–1974	1969–1971	1966–1968	1963–1965	1960–1962	1957–1959	1954–1956	1951–1953	1948–1950
Junior high school or less									
1996	–	−.07	−.01	.02	.03	.06	.06	.04	−.01
2001	−.08	−.16	.01	−.11	−.07	−.05	−.10	−.13	−.19
2006	−.06	−.13	−.13	−.05	−.10	−.10	−.12	−.19	–
High school or equivalent									
1996	–	0	.10	.15	.18	.25	.25	.34	.31
2001	−.02	.06	.07	.15	.14	.20	.20	.32	.30
2006	.07	.13	.12	.15	.18	.11	.18	.20	–
Some college or above									
1996	–	.07	.25	.39	.48	.53	.58	.61	.67
2001	.15	.32	.44	.51	.53	.64	.65	.69	.66
2006	.27	.40	.51	.51	.52	.58	.63	.48	–

B: 1984–1994									
Year	1960–1962	1957–1959	1954–1956	1951–1953	1948–1950	1945–1947	1942–1944	1939–1941	1936–1938
Junior high school or less									
1984	–	−.12	−.03	−.02	.00	−.02	.00	−.05	−.13
1989	.33	.34	.37	.35	.34	.32	.26	.22	.07
1994	.59	.61	.59	.61	.57	.51	.45	.33	–
High school or equivalent									
1984	–	0	.13	.21	.22	.30	.34	.41	[.30]
1989	.38	.50	.53	.59	.64	.65	.65	.58	[.70]
1994	.71	.76	.78	.81	.86	.92	.83	[.78]	–
Some college or above									
1984	–	.16	.33	.50	.56	.62	[.59]	[.74]	[.76]
1989	.54	.68	.77	.79	.90	.85	[.95]	[1.00]	[1.01]
1994	.92	1.04	1.07	1.12	1.24	[1.26]	[1.25]	[1.25]	–

Notes: columns are separated by three-year bands of household-head year-of-birth and rows are separated by household-head education attainment. All entries in the table are differences of average log household-head income of the corresponding cohort-year and that of the base cohort-year. For Panel A, the base is the cohort with a head born during 1969–1971 with high school education in 1996. For panel B, the base is the cohort born during 1957–1959 with high school education in 1984. Entries in brackets are calculated from samples with less than 100 observations. Data are from Survey of Family Income and Expenditure of Taiwan and calculations made by the author.

Table 1.4: Relative Changes in Consumption

A: 1996-2006									
Year	1972–1974	1969–1971	1966–1968	1963–1965	1960–1962	1957–1959	1954–1956	1951–1953	1948–1950
Junior high school or less									
1996	–	−.13	−.08	−.09	−.10	−.06	−.02	.01	−.02
2001	.00	−.08	−.03	−.07	−.08	.00	.02	.06	.00
2006	.05	−.06	.00	.03	.01	.02	.03	.01	–
High school or equivalent									
1996	–	0	.04	.06	.04	.09	.09	.16	.16
2001	.02	.07	.06	.09	.08	.12	.15	.20	.26
2006	.07	.14	.10	.09	.13	.12	.20	.20	–
Some college or above									
1996	–	.12	.20	.26	.31	.32	.36	.31	.46
2001	.15	.25	.27	.31	.32	.38	.42	.46	.46
2006	.23	.33	.31	.32	.34	.40	.44	.36	–
B: 1984–1994									
Year	1960–1962	1957–1959	1954–1956	1951–1953	1948–1950	1945–1947	1942–1944	1939–1941	1936–1938
Junior high school or less									
1984	–	−.10	−.07	−.08	−.06	−.04	.02	.03	.01
1989	.09	.10	.14	.16	.18	.21	.22	.19	.16
1994	.23	.27	.28	.34	.37	.33	.35	.27	–
High school or equivalent									
1984	–	0	.04	.07	.10	.09	.19	.20	[.18]
1989	.21	.23	.26	.29	.35	.33	.41	.41	[.50]
1994	.42	.41	.42	.45	.55	.57	.50	[.58]	–
Some college or above									
1984	–	.09	.18	.22	.24	.27	[.26]	[.37]	[.49]
1989	.37	.37	.39	.42	.47	.47	[.57]	[.56]	[.73]
1994	.65	.69	.67	.67	.82	[.79]	[.85]	[.90]	–

Notes: columns contain three-year bands of birth cohorts. Rows are separated by years and by head education attainment. For Panel A, the base is the cohort born from 1969 to 1971 with high school education or equivalent in 1996. Each cell in panel A is the difference between average log household nondurable consumption expenditures of the corresponding cohort-year and that of the base. For panel B, the base is the cohort born 1957–1959 with high school in 1984. Entries in brackets are calculated from samples with less than 100 observations. Data from Survey of Family Income and Expenditure of Taiwan and calculations made by the author.

Table 1.5: Unsmoothed Consumption Risk, 1985–2006

	Education & Birth		Birth cohorts	
Income	.36***	.37***	.32***	.34***
	(.03)	(.02)	(.04)	(.04)
Household controls	NO	YES	NO	YES
N	565	565	204	204

Note: Entries in the table represent unsmoothed consumption risk across different cohorts during the period 1985–2006. They are estimated $\hat{\theta}$ from equation $\widetilde{\Delta\log C}_{jt} = \theta\widetilde{\Delta\log X}_{jt} + \psi\widetilde{\Delta F}_{jt} + \widetilde{\varepsilon}_{jt}$. The dependent variable is cohort idiosyncratic consumption growth $\widetilde{\Delta\log C}_{jt} \equiv \Delta\log C_{jt} - \overline{\Delta\log C}_{.t}$. The mean consumption growth rate across cohorts in year t is $\overline{\Delta\log C}_{.t} \equiv N_t^{-1}\sum_j \Delta\log C_{jt}$. Consumption growth rate of cohort j is $\Delta\log C_{jt} \equiv \log C_{j,t} - \log C_{j,t-1}$. Cohort consumption is defined as the average of log nondurable consumption expenditures across households within cohort j: $\log C_{jt} \equiv N_{jt}^{-1}\sum_i^{N_{jt}} \log c_{it}$, where c_{it} is the nondurable consumption expenditures of household i in year t. $\widetilde{\Delta\log X}_{jt}$ and $\widetilde{\Delta F}_{jt}$ are similarly-defined idiosyncratic changes in household head income and household controls, respectively. Household controls include the average number of adults, the average number of children under and over age 5, and the average number of elderly. Education & birth cohorts are defined by three-year bands of household heads' year-of-birth, crossed by three levels of education attainment. Birth cohorts are defined solely by heads' year-of-birth, while averaging across all education levels within the same birth cohort. Models are estimated using GLS estimation, with heteroscedasticity and cohort specific autocorrelations in the error terms $\widetilde{\varepsilon}$. Standard errors are reported in the parenthesis. Estimated coefficients on household controls are abbreviated. *,** and *** denotes statistical significance at levels of 5%, 1% and 0.1%, respectively.

Table 1.6: Unsmoothed Risk in Sub-periods

Risk sharing coefficients	Education & Birth (1)	(2)	Birth cohorts (3)	(4)
$\theta_{1985-1989}$	.40***	.36***	.20*	.17*
	(.04)	(.04)	(.08)	(.07)
$\theta_{1990-1994}$	.43***	.39***	.33***	.30***
	(.06)	(.05)	(.09)	(.08)
$\theta_{1995-1996}$	.42***	.44***	.44**	.37**
	(.10)	(.09)	(.15)	(.13)
$\theta_{1997-2001}$	.23***	.27***	.22**	.35***
	(.05)	(.04)	(.07)	(.07)
$\theta_{2002-2006}$	.42***	.46***	.57***	.51***
	(.06)	(.05)	(.06)	(.08)
Household controls	NO	YES	NO	YES
N	565	565	204	204

Note: Reported values are unsmoothed consumption risk across cohorts of households during different sub-periods. Columns (1) and (2) report unsmoothed risk across education and birth cohorts, and columns (3) and (4) across birth cohorts. Education & birth cohorts are defined by three-year bands of household heads' year-of-birth, crossed by three levels of education attainment. Birth cohorts are defined solely by household heads' year-of-birth, while all education levels are averaged within the same cohort. Estimations are based on $\widetilde{\Delta\log C}_{jt} = \theta_{1985-1989}\widetilde{\Delta\log X}_{jt} + \theta_{1990-1994}\widetilde{\Delta\log X}_{jt} + \theta_{1995-1996}\widetilde{\Delta\log X}_{jt} + \theta_{1997-2001}\widetilde{\Delta\log X}_{jt} + \theta_{2002-2006}\widetilde{\Delta\log X}_{jt} + \psi\widetilde{\Delta F}_{jt} + \widetilde{\varepsilon}_{jt}$. C denotes nondurable expenditures. $\widetilde{\Delta\log C}_{jt}$ is demeaned cohort average consumption growth rate. Specifically, $\widetilde{\Delta\log C}_{jt} \equiv \Delta\log C_{jt} - \overline{\Delta\log C}_{.t}$, where $\Delta\log C_{jt} \equiv \log C_{j,t} - \log C_{j,t-1}$ is the growth rate of average consumption in cohort j and $\overline{\Delta\log C}_{.t} \equiv {N_t}^{-1}\sum_{j=1}^{N_t}\Delta\log C_{jt}$ is the mean consumption growth rate across N_t cohorts at time t. X denotes household-head income and F denote household controls, including the average number of adults, the average number of children under and over age 5, and the average number of elderly. I interpret $\theta_{1985-1989}$ to be the average amount of unsmoothed consumption risk during 1985–1989. Other θ are interpreted similarly. Models are estimated using GLS estimation, with heteroscedasticity and cohort specific autocorrelations in the error terms $\widetilde{\varepsilon}$. Estimated coefficients on household controls are abbreviated. *,** and *** denote statistical significance at levels of 5%, 1% and 0.1%, respectively.

Table 1.7: Channels of Risk Sharing, 1985–2006

Channels	Education & Birth	Birth cohorts
Household members	$.32^{***}$	$.41^{***}$
	(.03)	(.04)
Capital & credit markets	$.03^{***}$	$.05^{*}$
	(.01)	(.02)
Private Transfers	$.09^{***}$	$.10^{***}$
	(.01)	(.01)
Public Transfers	$.07^{***}$	$.06^{***}$
	(.01)	(.01)
Savings	$.11^{***}$	$-.01$
	(.03)	(.05)
Not smoothed	$.38^{***}$	$.39^{***}$
	(.03)	(.05)
N	565	204

Note: reported values are the amounts of consumption risk smoothed through each channel during 1985–2006. Education & birth cohorts are defined by three-year bands of household heads' year-of-birth, crossed by three levels of education attainment. Birth cohorts are defined solely by household heads' year-of-birth, while all education levels are averaged within the same birth cohort. The coefficient for household members is β^F from equation $\Delta \log HE_{jt} - \Delta \log TE_{jt} = \eta_t^F + \beta^F \Delta \log HE_{jt} + \upsilon_{jt}^F$, where HE denotes household-head income and TE for total household income. I interpret β^F to be the amount of consumption risk smoothed through income of household members. The coefficient for capital & credit markets is β^K from equation $\Delta \log TE_{jt} - \Delta \log NK_{jt} = \eta_t^K + \beta^K \Delta \log HE_{jt} + \upsilon_{jt}^K$, where NK is TE plus net interest and rental incomes. I interpret β^K to be the amount of risk smoothed through capital or credit market. The coefficient for private transfers is β^P from equation $\Delta \log NK_{jt} - \Delta \log NP_{jt} = \eta_t^P + \beta^P \Delta \log HE_{jt} + \upsilon_{jt}^P$, where NP is NK plus net private transfer income. I interpret β^P to be the amount of risk smoothed through private transfers. The coefficient for public transfers is β^T from equation $\Delta \log NP_{jt} - \Delta \log NT_{jt} = \eta_t^T + \beta^T \Delta \log HE_{jt} + \upsilon_{jt}^T$, where NT is NP plus net public transfers. I interpret β^T to be the amount of risk smoothed through public transfers. The coefficient for savings is β^S from equation $\Delta \log NT_{jt} - \Delta \log TC_{jt} = \eta_t^S + \beta^S \Delta \log HE_{jt} + \upsilon_{jt}^S$, where TC denotes total household consumption expenditures. I interpret β^S to be the amount of risk smoothed through household savings or borrowing. The unsmoothed risk is represented by θ^U from equation $\Delta \log TC_{jt} = \eta_t^U + \theta^U \Delta \log HE_{jt} + \upsilon_{jt}^U$. The equations are estimated by GLS. The β and θ^U are normalized to sum up to one. *,** and *** denote statistical significance at levels of 5%, 1% and 0.1%, respectively.

Table 1.8: Channels of Risk Sharing in Sub-periods

Channels	1985–1989	1990–1994	1995–1996	1997–2001	2002–2006
Household members	.38***	.26***	.36***	.36***	.20***
	(.04)	(.06)	(.10)	(.05)	(.06)
Capital & credit markets	−.02	.07**	−.06	.06**	.02
	(.02)	(.02)	(.05)	(.02)	(.02)
Private transfers	.12***	.10***	.05	.10***	.08***
	(.02)	(.02)	(.03)	(.02)	(.02)
Public transfers	.03***	.05**	.13***	.09***	.13***
	(.01)	(.01)	(.03)	(.01)	(.02)
Savings	.05	.14*	.07	.15**	.12*
	(.05)	(.07)	(.12)	(.06)	(.06)
Not smoothed	.44***	.38***	.45***	.25***	.46***
	(.06)	(.06)	(.11)	(.05)	(.06)

Note: Reported values represent the amounts of consumption risk smoothed through each channel in the relevant periods. The coefficients for household members are estimated β_P^F from equation $\Delta \log HE_{jt} - \Delta \log TE_{jt} = \eta_t^F + \beta_{1984-1989}^F \Delta \log HE_{jt} + \beta_{1990-1994}^F \Delta \log HE_{jt} + \beta_{1995-1996}^F \Delta \log HE_{jt} + \beta_{1997-2001}^F \Delta \log HE_{jt} + \beta_{2002-2006}^F \Delta \log HE_{jt} + \upsilon_{jt}^F$, where HE denotes household-head income and TE for total household income. I interpret $\beta_{1984-1989}^F$ to be the amount of consumption risk smoothed through income of household members during 1984–1989. Other θ_P^F are interpreted analogously. Similarly, the coefficients for capital & credit markets are β_P^K from equation $\Delta \log TE_{jt} - \Delta \log NK_{jt} = \eta_t^K + \sum_P \beta_P^K \Delta \log HE_{jt} + \upsilon_{jt}^K$, where NK is TE plus net interest and property income. I interpret β_P^K to be the amount of risk smoothed through capital or credit market in period P, where P denotes one of the sub-periods mentioned above. The coefficients for private transfers are β_P^P from equation $\Delta \log NK_{jt} - \Delta \log NP_{jt} = \eta_t^P + \sum_P \beta_P^P \Delta \log HE_{jt} + \upsilon_{jt}^P$, where NP is NK plus net private transfer income. I interpret β_P^P to be the amount of risk smoothed through private transfers in period P. The coefficients for public transfers are β_P^T from equation $\Delta \log NP_{jt} - \Delta \log NT_{jt} = \eta_t^T + \sum_P \beta_P^T \Delta \log HE_{jt} + \upsilon_{jt}^T$, where NT is NP plus net public transfers. I interpret β_P^T to be the amount of risk smoothed through public transfers in period P. The coefficients for savings are β_P^S from equation $\Delta \log NT_{jt} - \Delta \log TC_{jt} = \eta_t^S + \sum_P \beta_P^S \Delta \log HE_{jt} + \upsilon_{jt}^S$, where TC denotes total household consumption expenditures. I interpret β_P^S to be the amount of risk smoothed through household savings or borrowing in period P. The unsmoothed risk is represented by θ_P^U from equation $\Delta \log TC_{jt} = \eta_t^U + \sum_P \theta_P^U \Delta \log HE_{jt} + \upsilon_{jt}^U$. All equations are estimated by GLS. The β_P and θ_P^U are normalized to sum up to one for each period. Cohorts are defined by three-year bands of household heads' year-of-birth, crossed by three levels of education attainment. Number of observations is 565. *,** and *** denote statistical significance at levels of 5%, 1% and 0.1%, respectively.

Chapter 2

Empirical studies on income inequality in Taiwan

2.1 Introduction

Income inequality have macroeconomic implications (Heathcote et al. (2010b)). Recent systematic studies exist for developed countries such as the United States and Britain (Heathcote et al. (2010a) and Blundell and Etheridge (2010)). Using similar approach, this study examines changes in income inequality in Taiwan during the past three decades. I studied inequality both on the individual and household levels. On the individual level, I use information on after-tax labor income from the Pseudo-Panel Survey of Human Capital (PPSHC), a representative survey of all Taiwanese residents. On the household level, I use information on household income and consumption expenditures from the Survey of Family Income and Expenditure (SFIE) of Taiwan.

I use four measures of inequality: the variance of log, the Gini coefficient, the P50-P10 ratio and the P90-P50 ratio. The P50-P10 ratio is defined as the ratio of the median (the 50th percentile) to the bottom 10th percentile. The P90-P50 ratio is analogously defined. Because the variance of log wage is sensitive to small values of wage, it is more sensitive to the lower part of wage distribution. Thus, the variance of log should move more closely with the P50-P10 ratio than with the P90-P50 ratio. By comparison, the Gini coefficient is more sensitive to the upper part of wage distribution and thus should move more closely with the P90-P10 ratio. The discrepancies between the variance of log and the Gini coefficient may shed light on whether the changes in inequality are caused by changes in the upper or lower part of wage distribution.

The data shows that there was a decrease in wage inequality among men in the lower part of male wage distribution during 1980–2011. By comparison, female wage inequality was generally stable in the lower part of female wage distribution during the same period. Both male and female wages did not exhibit significant trends in the upper part of wage distribution. Furthermore, I look at wage differences across different education and age groups and across the gender. There were decreasing wage differences between college-educated and non-college-educated workers during 1980–2011. Nevertheless, the relative number of college-educated workers increased substantially during the same time. Both male and female workers in the senior group aged from 41 to 55 earned lower wages than those in the junior group aged from 25 to 40, but this phenomenon was reversed at the end of the sample period. The ratio of the average wage of male workers to that of female workers decreased rapidly from 1980 to 2011.

Inequality of household income among the working-age population aged from 25 to 55 increased rapidly after the mid-1990s. I looked at the changes in household income by different income percentiles and found that the primary reason was that households in the bottom part of income distribution were more severely affected by economic recessions in 2001. Furthermore, I examined how various factors affected household income inequality. Income of household members as well as net cash benefits greatly reduced household income inequality. On the contrary, net asset income increased household income inequality. Net private transfers reduced household income inequality to a small extent while taxes barely had any effect. Finally, inequality of household consumption was lower than that of household-head income.

Non-durable-consumption inequality increased in the first half the 1990s in the upper part of consumption distribution and decreased thereafter. By comparison, inequality in non-durable consumption was largely trendless in the lower part of consumption distribution.

The rest of this chapter is organized as follows. Section 2 talks about the data. Section 3 shows the statistics in the labor force participation, wages and hours worked among the whole population. Section 4 discusses wage inequality on the individual level within the working-age population. Section 5 examines income inequality on the household level and Section 6 concludes.

2.2 Data

I use the Pseudo-Panel Survey of Human Capital for the study of individual-level wage inequality. PPSHC is an annual survey of Taiwanese individuals on their participation in the labor market. Detailed information is available on the individual-level within each surveyed household. The households are surveyed for two consequent years and about half of the sample are replaced in each year. For the purpose of this study, I treat the households in each year as cross-section samples and I assume that each sample is representative of the population. The PPSHC data is available from 1980–2011 and the sample size ranges from 10,000 households in the early 1980s to around 12,000 households in end of sample period.

2.3 General statistics

2.3.1 Income trend from two data sources

Fig. 2.1 compares the average log real household income from PPSHC with that from SFIE, where household income is defined as the sum of labor income of all household members[1]. Household income from the SFIE data is defined on the annual base

[1] Labor income includes salaries, pensions and welfare. Although SFIE reports income from other sources such as interest incomes, PPSHC reports only labor income of the individuals.

while household income from the PPSHC data is imputed from monthly income[2]. In both samples, households with members as employers, civil servants and military personnel are excluded, in accordance with the previous chapter. In addition, I select the working-age households, where the ages of the household-heads are confined to be between 25 and 55 years old. The solid line represents household income imputed from the PPSHC data and the dashed line represents household income reported in the PPSHC data.

Household income increased substantially during the 1980s and the early 1990s. If measured by PPSHC, real household income increased by 109% from 1983 to 1994 and remained largely stable after 1995. In addition, household income measured in the two data sources are quite similar. Although the household income measured by SFIE was on average 4% higher than that measured by PPSHC before 1993, the discrepancy became much smaller thereafter.

2.3.2 Labor force participation

Fig. 2.2 shows the labor force participation rate for men and women. The labor force is defined as the population aged from 16 to 65 years old, who are either working or are unemployed and actively seeking for jobs. Male workers had higher rate of participation in the labor market than did the female workers, but the gap across the gender was shrinking. Specifically, the male labor force participation rate was largely stable at around 76% during 1980 and 2011. By comparison, the female labor force participation rate gradually increased from 35% in 1980 to 56% in 2011. As a result, the overall labor force participation rate of the population increased from 57% to 66% during 1980–2011.

Fig. 2.3 shows that the unemployment rate among female workers moved closely to that among male workers. Nevertheless, female workers had higher unemployment rate before 1996 than did male workers, but not so thereafter. The unemployment

[2]Because PPSHC only reports monthly income for each individual, annual income is imputed by multiplying the monthly income by the number of twelve. I assume that the potential discrepancies between the imputed annual income and actual annual income will converge to zero by taking the average of income of all households.

rate for both sexes rose rapidly after 1994. For male workers, the unemployment rate increased to a peak of 6.0% in 2003 from about 2.0% in the early 1990s. There was also an surge in the unemployment rate among female workers after 1994, but it was lower at 5.3% in 2003 and the female unemployment rate was more stable than mens' in the late 2000s.

2.3.3 Wages and hours

Fig. 2.4 shows the real average hourly wage and weekly hours for men and women during the sample period. The hourly wage is defined as the monthly labor income divided by monthly hours, which are imputed from regular weekly hours[3]. The currency of the hourly wage is New Taiwan Dollar (NTD).[4] The real hourly wage for both men and women were increasing substantially from 1980 to 2000. Nevertheless, the average real wage of female workers grew faster so that it was catching up with that of male workers. Specifically, the female hourly wage increased by 237% from 1980 to 2011 while the increase for male workers was 171%. In addition, the weekly hours of both male and female workers decreased by a similar extent. The average male weekly hours decreased from about 51 hours to 45 hours while that of female workers decreased from 49 hours to 44 hours.

2.4 Individual-level inequality

2.4.1 Wage inequality

As a first step, I show the wage inequality on the individual level in Fig. 2.5, where I measure inequality by the variance of log wage. The figure shows that the individual-level wage inequality declined from 1980 to 2011, despite the temporary increases during 1980–1986 and 1999–2002.

Fig. 2.6 displays the trends in wage inequality by gender. The top left panel of

[3]The PPSHC data only reports regular weekly hours but not the monthly hours.

[4]The exchange rate between NTD and USD fluctuated between the maximum of 40.1 (1 USD = 40.1 NTD) in 1983 and the minimum of 25.2 in 1992.

the figure shows that the variance of log hourly wage for male workers declined by around 6 log points from 1980 to 2011 and closely resembled the overall trend in Fig. 2.5. By comparison, the variance of log wage for female workers was largely trendless. Because the variance of log wage is more sensitive to the changes in the bottom part of wage distribution, I show the ratio of median income to the bottom 10% income (the P50-P10 ratio) in the bottom left panel of the figure. Indeed, there is an overall downward trend in the P50-P10 ratio among male workers and the relevant ratio was trendless among female workers.

Furthermore, the top right panel of Fig. 2.6 shows the Gini coefficient of hourly wage, which is more sensitive to the changes in the top part of wage distribution. The Gini coefficients are trendless for both men and women. The P90-P50 ratios shown in the bottom right panel of the figure yields similar conclusions. In sum, the above evidence suggests that the decrease in wage inequality in the bottom part of wage distribution happened within male workers and not within female workers. By comparison, there are no obvious upward or downward trends in wage inequality within both male and female workers in the top part of wage distribution.

2.4.2 Inequality by sub-groups

The previous section shows that there was a decrease in wage inequality on the individual level from 1980 to 2011, this section tries to decompose the sources of this decrease by investigating the wage differences across different demographic groups. Specifically, I use univariate analysis to check whether changes in these wage differences help to explain the decreasing wage inequality.

The top left panel of Fig. 2.7 shows the college-education wage premium for men and women. The college wage premium is defined as the college-education wage ratio minus one, where the the college-education wage ratio is defined as the average wage of college-educated workers divided by the average wage of workers without any college education. Because of the significant changes in demographics, I also show the ratio of the number of workers in the two groups in the top right panel.

The college wage premium among working men increased from 79% in 1980 to 102% in 1987, which would increase the wage inequality among working men if holding other things constant. By comparison, the male college premium gradually decreased to 43% in 2011, which tended to decrease the male wage inequality. However, the ratio of the number of college-educated men to the number of non-college-educated men increased substantially from .06 in 1987 to .30 in 2011. Rising relative number of college-educated working men tended to increase the male wage inequality because college-educated men earn higher wages than non-college-educated men. As a result, the relative increase in the number of college men largely offset the effect of decreasing college premium and caused the male wage inequality to decrease only slightly from 1987 to 2011. Comparing 1980 and 2011, although the male college premium was lower in 2011, the increase in the relative number of college men was so large that the male wage inequality would be larger in 2011 than in 1980 if holding other things constant. Analogous analysis of the changes in the female college premium leads to similar conclusions. In sum, decreasing college wage premium does not explain the decrease in individual wage inequality from 1980 to 2011 due to rising relative number of college-educated workers.

The bottom left panel of Fig. 2.7 shows the trends of age premium, which is defined as the age wage-ratio minus one, where the age wage-ratio is defined as the average wage among the working people who are aged from 41 to 55 years old divided by the average wage of those who are aged from 25 to 40 years old in any year[5]. The young male cohort earned more, on average, than did the senior male cohort in 1980 and thus the age premium was minus 9%. The male age premium increased to 0% in 1992, which tended to decrease the male wage inequality because the differences in male wages across age groups became smaller. Nevertheless, the age premium for male workers increased significantly from 1% in 1993 to 17% in 2011 while the relative

[5]Because people of different ages in any given year are born in different years, the age wage premium contains cohort effects (i.e. the younger cohort may have higher lifetime wealth and their income might be higher than the older cohort). Nevertheless, it is not a problem for the purpose of decomposing the sources of changes in inequality, which does not require the separation of cohort effects.

number of aged male workers increased from .9 to 1.4 during the same time. The net effect is that male wage inequality would increase from 1993 to 2011. Comparing 1980 and 2011, there would be higher male wage inequality in 2011 because of higher age premium.

For female workers, the age premium increased from -11% in 1980 to 0% in 1987, which tended to decrease the wage inequality among female workers towards zero. The female age premium stayed relatively stable at around 0% until 2007. Thus, it could barely influence the female wage inequality during this time. Nevertheless, the female age premium rose rapidly from .1% in 2007 to 12% in 2011, which tended to increase the female wage inequality back to the 1980 level. In sum, changes in the female age premium could not explain the decrease in wage inequality.

The above analysis focuses on the effects of the changes in education and age premiums, the following discussion will be centered around gender wage premium. Fig. 2.8 shows the gender wage ratio (solid line) and the gender employment ratio (dashed line) of working men to working women. The gender wage premium is defined as the ratio of the average hourly wage of working men to that of working women minus one, and the gender employment ratio is defined as the number of working men to the number of working women. The gender wage premium fluctuated around 55% from 1980 to 1991, which would barely affect the wage inequality. However, the gender employment ratio decreased from 2.4 in 1980 to around 2.0 in 1991, which tended to increase the wage inequality while holding other things constant. The reason is that there were relatively more female workers who would typically earn lower wages. The gender wage premium declined sharply from 54% in 1991 to 24% in 2011 and this would decrease the wage inequality if holding other things constant. Meanwhile, the gender employment ratio declined to 1.4 in 2011, which tended to increase the wage inequality. Nevertheless, the effect of decreasing gender employment ratio is relatively small to the effect of decreasing gender wage premium. Comparing 1980 and 2011, the net effect of a lower gender wage premium and a relatively larger female workforce is that the wage inequality would decrease from 1980 to 2011 if holding other things constant. Thus it is consistent with the fact in Fig. 2.5.

The top panels of Fig. 2.9 show the changes in gender wage ratio and employment ratio by education groups, where the solid line denotes the college-educated group and the dashed line denotes the non-college-educated group. There were large fluctuations in the gender wage ratio among college-educated workers. Therefore, I use the average gender wage premium prior and after 1995[6] to discuss the effect of the changes in gender wage premium. The average gender premium within the college group was 39% during 1980–1995 while the average employment ratio was 2.6. By comparison, the relevant numbers during 1996–2011 were 31% and 1.4, respectively. Though decreasing gender wage premium from 1980–1995 to 1996–2011 tended to decrease the wage inequality within the college group, the lower employment ratio during 1996–2011 partially reversed this effect. In net effect, there would only be a slight decrease in wage inequality from 1980–1995 to 1996–2011.

By comparison, the gender wage premium in the non-college group declined from 54% during 1980–1995 to 36% during 1996–2011, and the employment ratio decreased from 2.1 to 1.6 during the same time. Clearly, the gender wage premium dropped by more within the non-college group and the employment ratio decreased by less than did those in the college group. Therefore, there would be larger drop in wage inequality in the non-college group than in the college-group. Considering that the non-college group was much larger than the college group (Fig. 2.7), the effect of decreasing gender premium in the non-college group would exert larger influence on the overall wage inequality than would that in the college-group. In other words, the effect of decreasing gender wage premium illustrated in Fig. 2.8 was concentrated mainly in the non-college group.

The bottom panels of Fig. 2.9 show the trends of gender wage ratio and employment ratio by age cohorts. The solid line on the bottom left panel shows that the average gender wage premium within the young cohort decreased from 52% in 1980 to 18% in 2011, which would decrease the wage inequality among young workers if

[6] So that there are 16 years of observation both prior and after this cutoff year.

holding other things constant. Meanwhile, the gender employment ratio within the young cohort fell from 3.1 in 1980 to 1.2 in 2011, which tended to increase the wage inequality because there were relatively more women who earned lower wages than did men. Nevertheless, this effect only partially offset the effect of decreasing gender wage premium. Thus the net effect is that the wage inequality among young workers would decrease due to lower gender wage premium. Although both the gender wage premium and gender employment ratio were higher in the senior cohort (aged 41 to 55), the trends were similar to those among the young cohort. Therefore, lower gender wage premium would also decrease the wage inequality within the senior workforce.

The above analysis shows that there were substantial changes in wage differences across different groups with respect to education, age and gender. Thus, it is interesting to examine the relative importance of observable individual characteristics relative to the unobservable ones such as ability in explaining the changes in wage inequality. I show in Fig. 2.10 the raw and residual-wage-inequality across years. The residual wage inequality in each year is defined as the variance of log residuals from a cross-sectional regression of log wage on a set of observable demographics, which include dummies of sex, education, age, work locations and occupations. The figure shows the residual wage inequality dropped by 3 log points from 1980 to 2011. By comparison, the drop in raw wage inequality was more than 6 log points during the same period. Therefore, about half of the decrease in individual-level wage inequality could be explained by changes in wage returns to observable individual characteristics.

In summary, this section analyzes three important factors which might influence wage inequality: gender, education and age. The decreasing gender wage premium was important in explaining the decline in the individual-level wage inequality from 1980 to 2011. Moreover, the effect of the decline in gender wage premium was concentrated mainly within the non-college educated workforce instead of within the college-educated workforce. By comparison, the decline in the gender premium occurred both within the younger cohort as well as within the senior cohort. On the contrary, the decrease in wage inequality could not be caused by the decrease in the college-education wage premium because of rising relative number of college-educated workers. Also, the decrease in wage inequality could not be explained by the changes in the age wage premium, which increased from 1980 to 2011. Finally, about half of the changes in wage inequality could be explained by changes in wage returns to observable individual characteristics during 1980–2011.

2.5 Household-level inequality

In this section, I analyze the changes of income and consumption inequality on the household level by using the SFIE data.[7] In order to eliminate the effect of changes in demographics, I use the OECD equivalence scale to obtain the per-adult-equivalent household income and consumption.[8] Because the variance of logs is sensitive to very small values, I discard households whose household-income rank below the bottom .5% in each year.

Fig. 2.11 shows the trends of inequality in equivalized household income by four measures: variance of logs, Gini coefficient, the P50-P10 ratio and the P90-P50 ratio. Both the variance of logs and the P50-P10 ratio show that household-income inequality increased rapidly from 1994 to 2002. During this period, the variance of logs increased by 10 log points and the P50-P10 increased from less than 1.75 to around 2.0. Nevertheless, the P90-P50 ratio did not increase until 1998, implying that the increase in income inequality happened somewhat later in the upper part of income distribution.

To investigate why income inequality increased across the households, I show in Fig. 2.12 the difference of log equivalized household income against that in year 1994 at different income percentiles.[9] Households in the bottom part of income distribution

[7] The SFIE data contains more detailed information on income from various sources such as asset income, private transfers and net benefits, which would be necessary for the analysis of this section. By comparison, the PPSHC data contains only after-tax labor income.

[8] The OECD equivalence scale assigns 1 to the first adult (household-head), .7 to each additional adult and .5 to each child. A child status is determined by the self-report information that whether the household member is a child or grandchild of the household head. In addition, I make the restriction that the age of a child should not exceed 22 and he or she should not be working and should not have labor income.

[9] As is expected from Fig. 2.11, growth in household income was very similar across percentiles

hardly experienced any real income growth from 1994 to 2006. By comparison, income of households in the top continued to grow during 1994–2006, though at a lower rate than that before 1994. In addition, households in the bottom tended to be more severely affected by recessions. For example, income of households in the bottom 5th percentile dropped by about 15 log points in 2001. On the contrary, household income in the top 95th percentile was barely affected in the same year.

Consumption is an important measure of welfare. Thus the following will focus on how income inequality is transmitted to consumption inequality. Specifically, I analyze whether each income source would reduce income inequality so as to reduce the potential inequality in consumption. In addition, the following analysis will focus on the variance of logs and the Gini coefficient in studying income inequality.

The solid lines in the top panels of Fig. 2.13 plot the trends in income inequality among the household heads[10] and the dashed lines are for equivalized total household income. Clearly, income inequality among the household heads was consistently higher than inequality across the households. This indicates that income of other household members helped to reduce inequality across the households. The bottom left panel of the figure shows that income inequality among the households without a spouse was higher than that among married households. Meanwhile, income inequality increased from 1994 to 2002 within both groups. The bottom right panel of the figure shows that the fraction of married households dropped steadily from 85% in 1983 to 67% in 2006. Therefore, the increase in income inequality across the households was caused both by higher levels of within-group income inequality and a shift from marriage to singles among the households.

The top panels of Fig. 2.14 show the effect of net asset income on income inequality, where net asset income is defined as interest income plus dividends and

from 1983 to 1993. Thus I omit these years for clarity.

[10]Note that income inequality among the household heads decreased from the early 1980s to the mid 1990s, which is consistent of the finding in the previous section. Nevertheless, inequality among the household heads may not necessarily be identical to that among all individual workers, simply because the latter group contains a larger sample. Thus, the increase in income inequality among the household heads after 1995 may not violate the observation that income inequality among all individuals did not increase after 1995.

property income, minus interest expenditures. The solid lines represent inequality of household income and the dashed lines represent that of household income plus net asset income. Under both measures of inequality, net asset income increased income inequality among the households. Not surprisingly, it indicates that higher-income households also tend to have relatively higher net asset income, both in the upper and lower parts of income distribution. The dashed lines in the bottom panels represent inequality of the income underlying the solid lines plus net private transfer income. Therefore, the figure shows that net private transfers lowered income inequality during 1983–2006 and this effect did not change over time.

The top panels of Fig. 2.15 show the effect of net cash benefits on income inequality. Net benefits includes government subsidies plus cash benefits from social insurances minus premium expenditures. Net benefits barely affected income inequality before 1995, both in the upper and lower parts of income distribution. By comparison, net benefits substantially reduced income inequality after 1995. Although the Gini coefficient of plus-private-transfer-income increased from .27 in 1983 to .29 in 2006, the corresponding Gini coefficient of plus-net-benefit-income was still .27 in 2006. The trends of variance of logs lead to the same conclusion. This is consistent with the inauguration of National Health Insurance (NHI) in March 1995.[11] The NHI provided insurance coverage to non-working household members who were not covered by any health insurance before 1995. Therefore, the figure suggests that households with lower income benefited more from the NHI than did higher-income households.

The last item needed to reach the household disposable income is tax and the bottom panels of Fig. 2.15 show the effect of taxes on income inequality. The solid lines denote inequality of equivalized pre-tax household income and the dashed lines denote inequality of equivalized household disposable income. Perhaps surprisingly, taxes barely affect income inequality, especially in the lower part of income distribution. It indicates that taxes were not proportionate enough so as to curb on income

[11]The cash benefits from NHI was contingent upon illness. Nevertheless, I include it as part of disposable income because it offset health expenditures. My definition of non-durable consumption below does not include health expenditures to keep accordance with the previous chapter. In that sense, cash benefits could influence non-durable consumption.

inequality in the bottom part of income distribution. Nevertheless, the trends in Gini coefficients show that taxes lowered income inequality to some extent in the upper part of income distribution.

Finally, Fig. 2.16 plots inequality of disposable income and non-durable consumption expenditure.[12] The top left panel of the figure shows that the variance of log consumption was less than that of disposable income, an observation consistent with standard economic theory. The variance of log non-durable expenditure increased by 5 log points from 1983 to 1995 and declined by about 3 log points after 1995. The top right panel of the figure shows an even more curved shape of non-durable inequality. The bottom panels show that increase in consumption inequality during the early-1990s happened mainly in the upper part of income distribution, and not in the lower part.

In summary, inequality in household labor income increased substantially during 1983–2006, most of which happened after 1994. Nevertheless, income of household members greatly decreased the level of income inequality and net benefits offset most of the increase in income inequality. Furthermore, the changes in consumption inequality happened mainly within the upper part of income distribution.

2.6 Conclusion

This study analyzes economic inequality in Taiwan from the 1980s to the 2010s, both on the individual and household levels. Female workers became more important during this period as the female labor force participation rate increased substantially and the average female hourly wage was catching up with that of men. In fact, decreasing wage differences across gender helped to explain the phenomenon that individual-level wage inequality was decreasing from 1980 to 2011. Although the a decreasing employment ratio of female to male workers tended to increase wage inequality, this effect did not full reverse the effect of decreasing ratio of the average female wage to that

[12] The non-durable consumption includes food, tobacco and alcohol, clothing, utilities, home non-durable (textiles, kitchen and dining and such), transportation and utilities, leisure and recreation, personal care and miscellaneous.

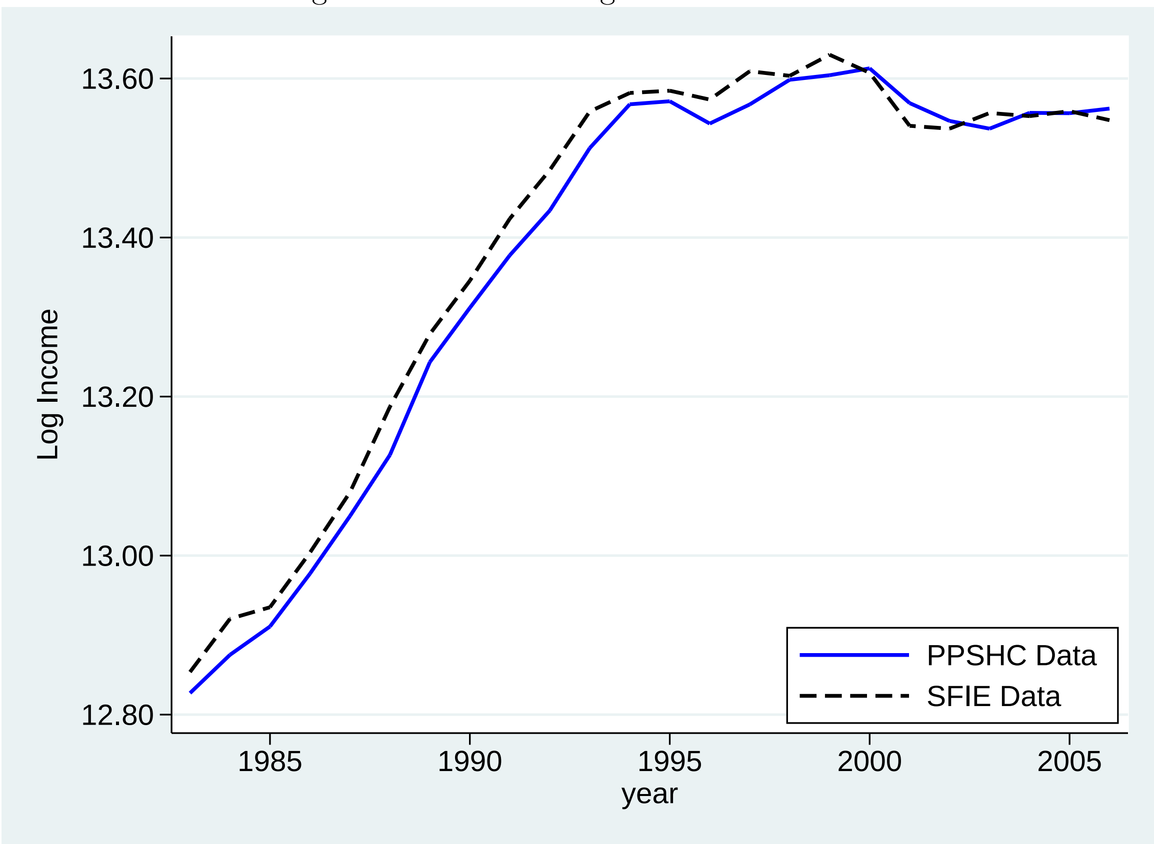
of men. Moreover, the effect of decreasing wage differences between female and male workers was more significant among the non-college-educated group than among the college-educated group.

By contrast, univariate analysis shows that changes in wage differences across education and age-groups were not important in explaining the decline in individual-level wage inequality. The average wage of college-educated workers was catching up with that of non-college-educated workers, which tended to increase wage inequality. However, the relative number of college-educated workers increased so large as to full offset the effect of decreasing wage ratios across education groups. The wage differences across age cohorts decreased in the 1980s but increased thereafter. In net effect, these changes would only increase wage inequality slightly if holding other things constant.

Furthermore, within-gender income inequality was generally trendless except within male workers in the lower part of income distribution, in comparison to the decreasing wage differences across gender. Changes in returns to observable individual characteristics explained about half the changes in wage inequality during the sample period.

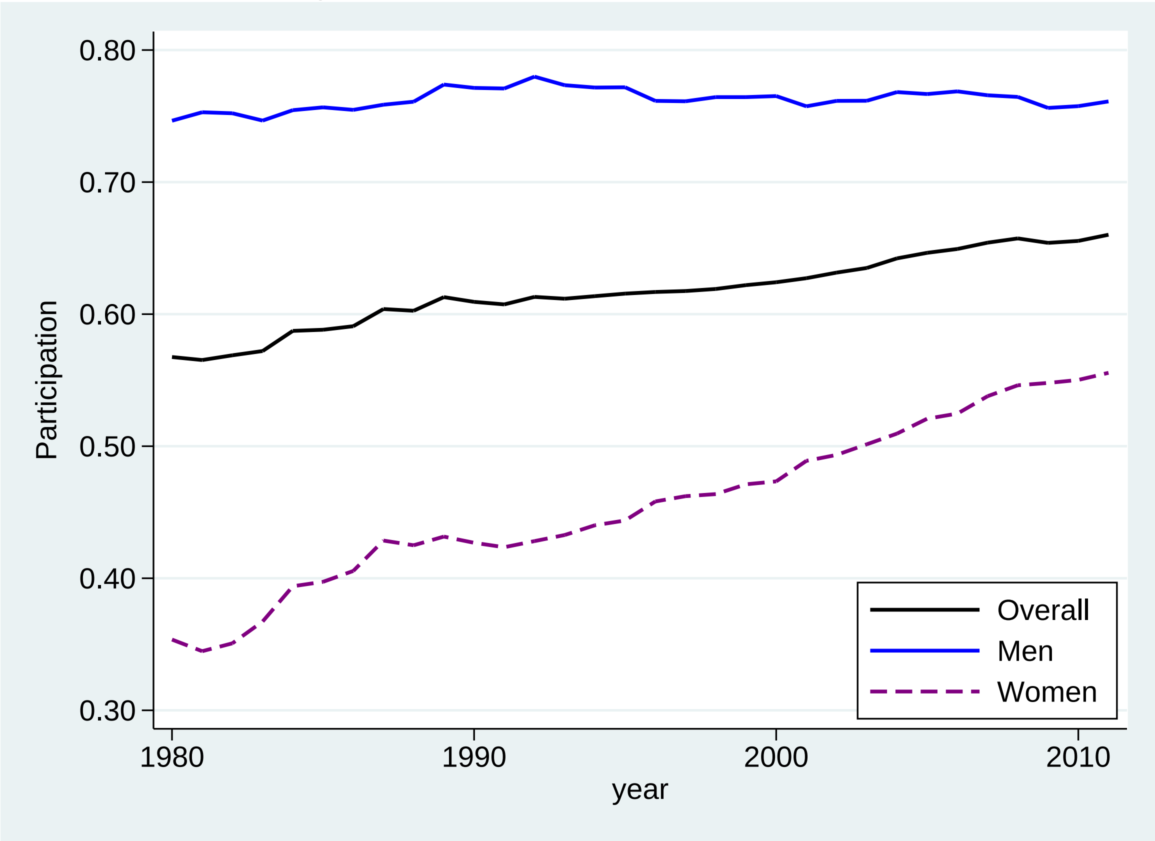
On the household level, income inequality increased after the mid-1990s, primarily because households in the bottom part of income distribution were more severely affected by the economic recessions in 2000 and 2001. Nevertheless, labor income of household members significantly reduced household-income inequality in any period. Moreover, net cash benefits was also important in reducing income inequality after 1995. Finally, consumption inequality was lower than income inequality but it increased in the upper part of income distribution while that in the lower part remained largely stable.

Figure 2.1: Mean of Log Household Income



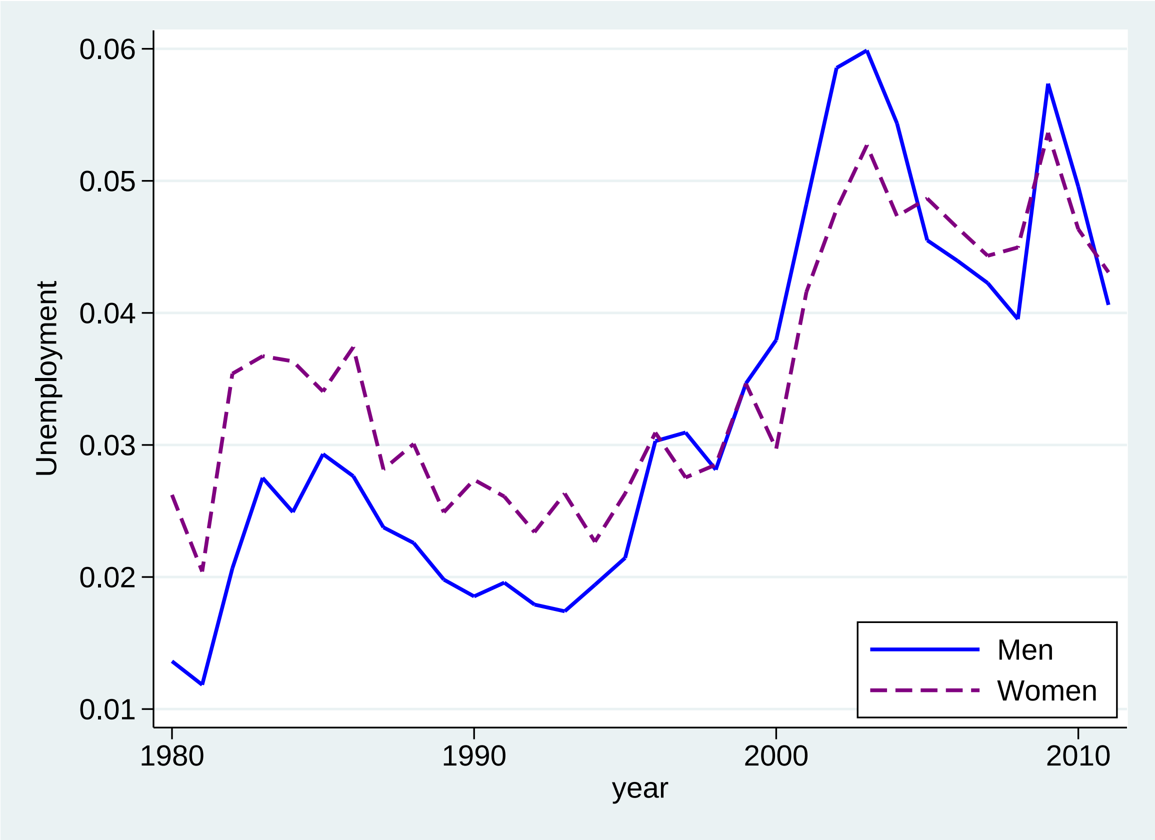
Note: Household income includes after-tax labor income of all household members. The population is confined to the working-age group (age 25–55). Data is from the Pseudo-Panel Survey of Human Capital (PPSHC) and the Survey of Family Income and Expenditure (SFIE). Calculation is made by the author.

Figure 2.2: Labor Force Participation Rate



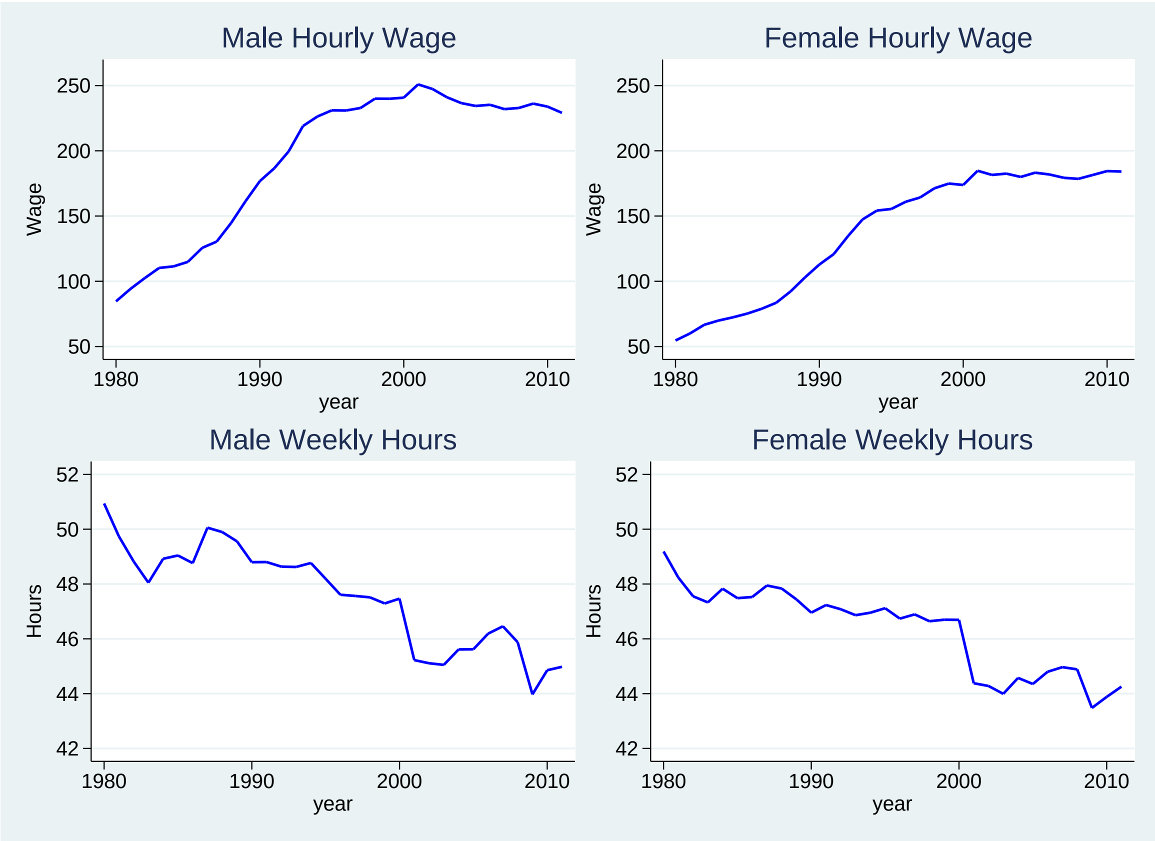
Note: The labor force participation rate is defined as the percentage of workforce (employed people or unemployed people who are actively seeking for jobs) in the population aged from 16 to 65 years old. Data is from PPSHC and calculation is made by the author.

Figure 2.3: Unemployment Rate



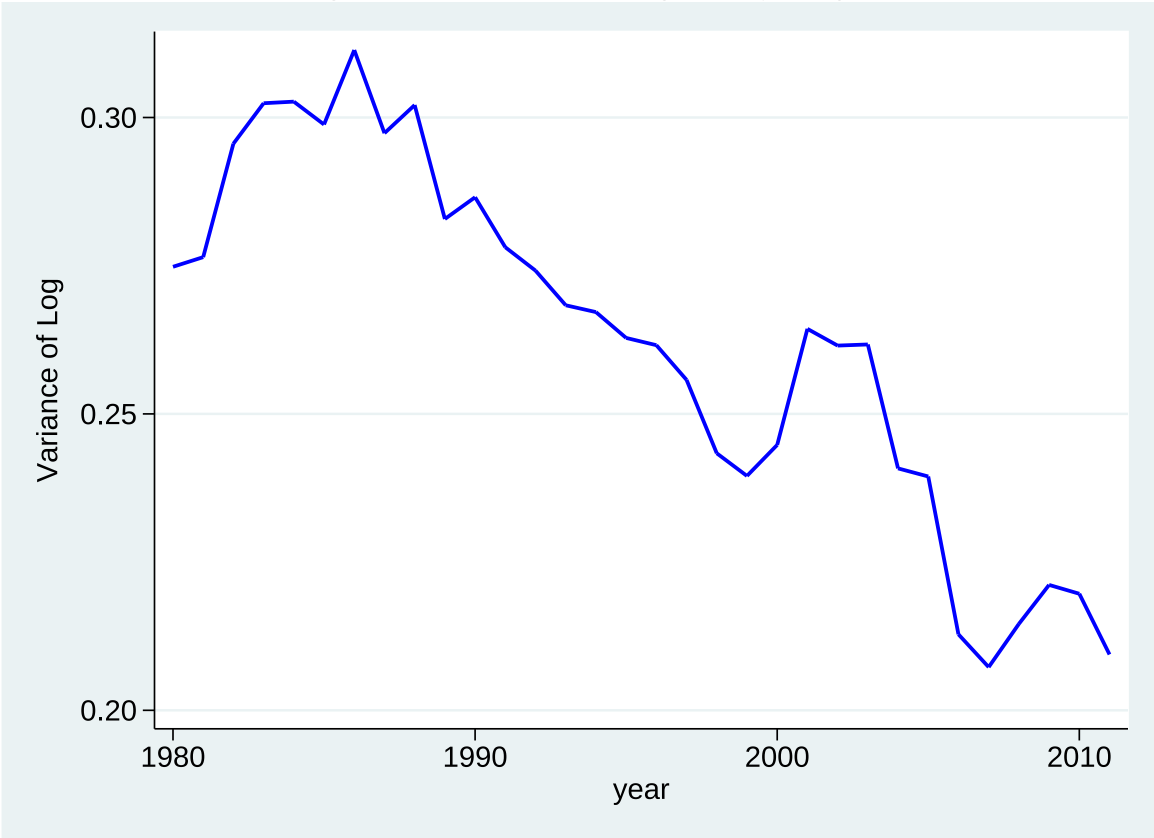
Note: The unemployment rate is defined as the percentage of employed people in the workforce aged from 16 to 65 years old. Data is from PPSHC and calculation is made by the author.

Figure 2.4: Wages and Hours



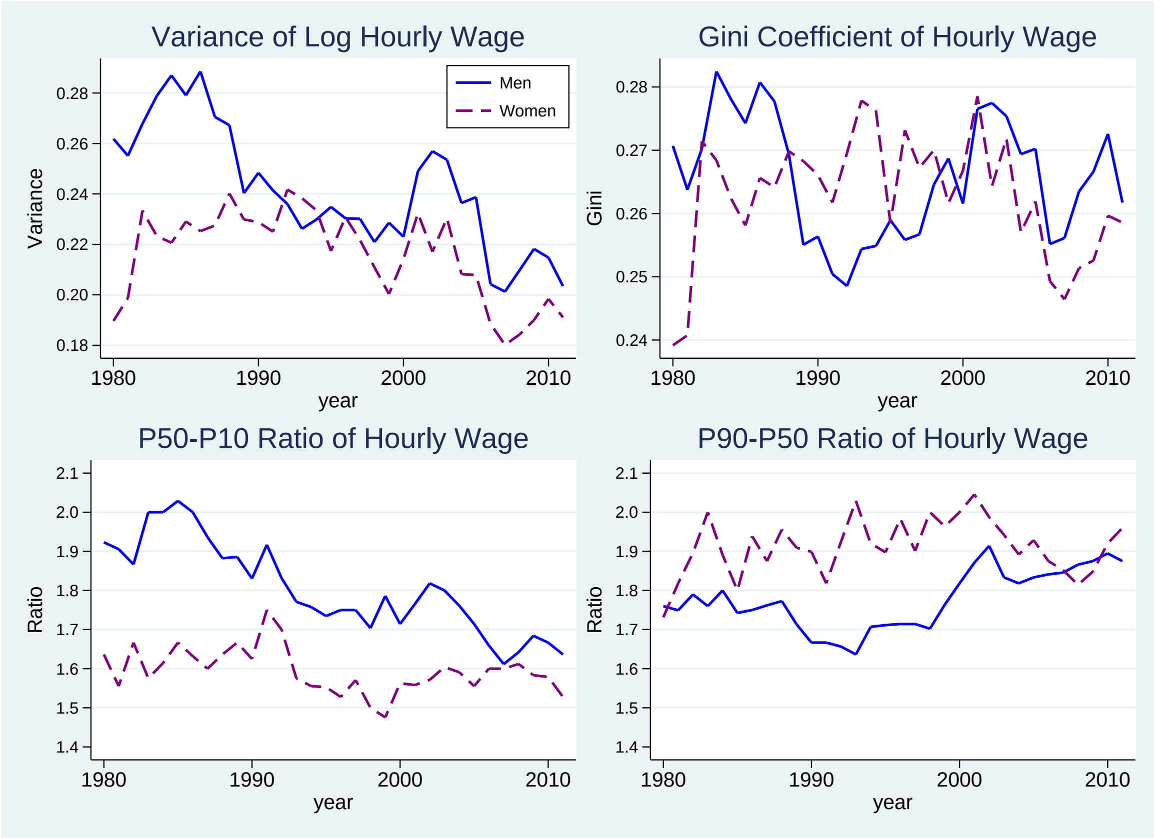
Note: Hourly wage is defined as the monthly labor income divided by monthly hours, which are imputed from regular weekly hours. Data is from PPSHC and calculation is made by the author.

Figure 2.5: Variance of Log Hourly Wage



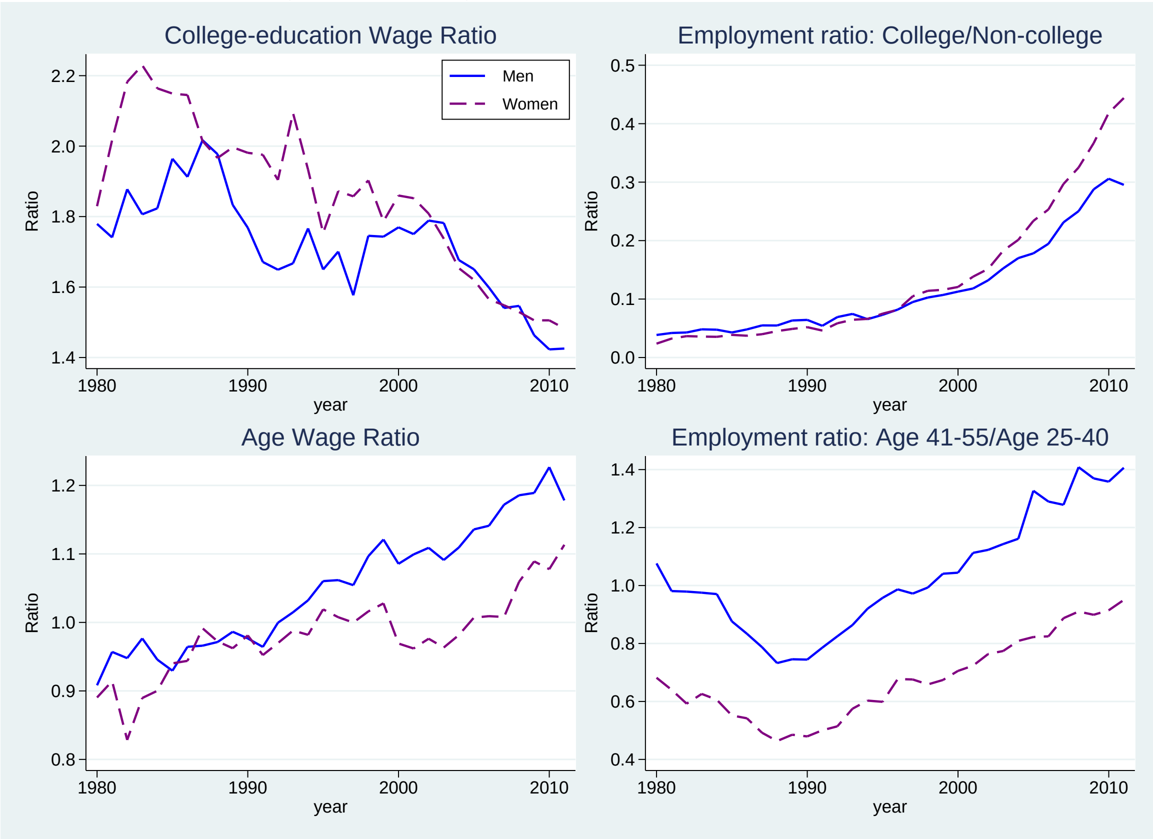
Note: Hourly wage is defined as the monthly labor income divided by monthly hours, which are imputed from regular weekly hours. People under the bottom .5% in the wage distribution are excluded. Data is from PPSHC and calculation is made by the author.

Figure 2.6: Wage Inequality by Gender



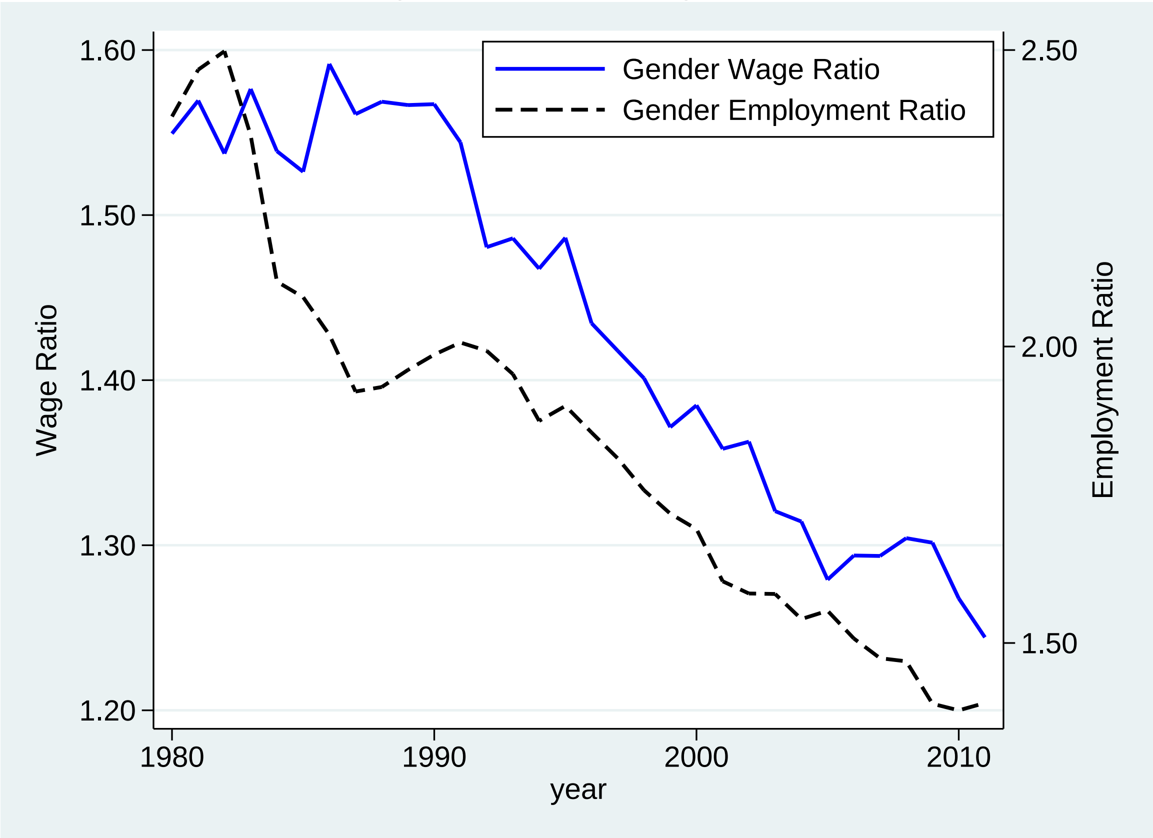
Note: Hourly wage is defined as the monthly labor income divided by monthly hours, which are imputed from regular weekly hours. The P50-P10 ratio is the median wage divided by the wage in the bottom 10% percentile. The P90-P50 ratio is similarly defined. Data is from PPSHC and calculation is made by the author.

Figure 2.7: Wage Ratio and Employment Ratio



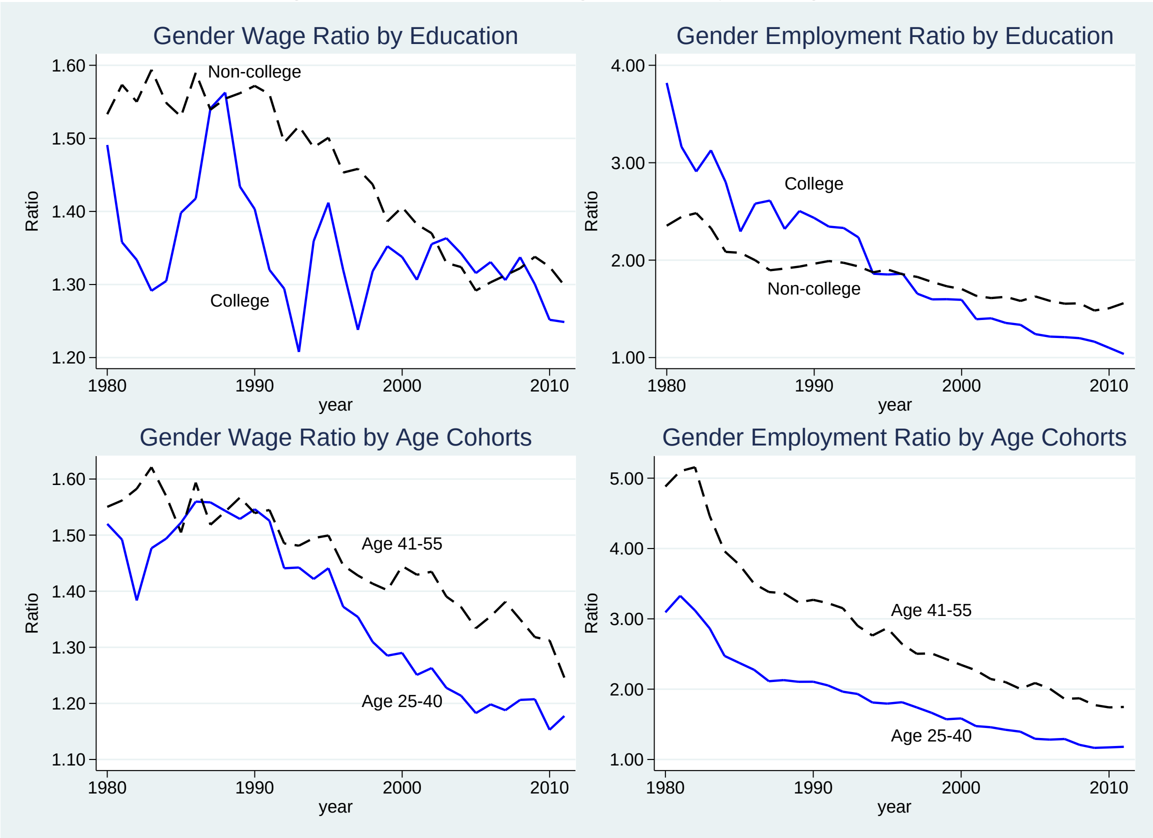
Note: The college-education wage ratio among men is defined by dividing the average hourly wage of college-educated male workers by their non-college-educated counterparts. The college-education employment ratio for men is defined by dividing the number of college-educated male workers by the number of non-college-educated male workers. The age wage ratio among men is defined by dividing the average wage of male workers aged from 41 to 55 years old by that of those aged from 25 to 40 years old. The age employment ratio is analogously defined to the college-education employment ratio. Data is from PPSHC and calculation is made by the author.

Figure 2.8: Gender Wage Ratio



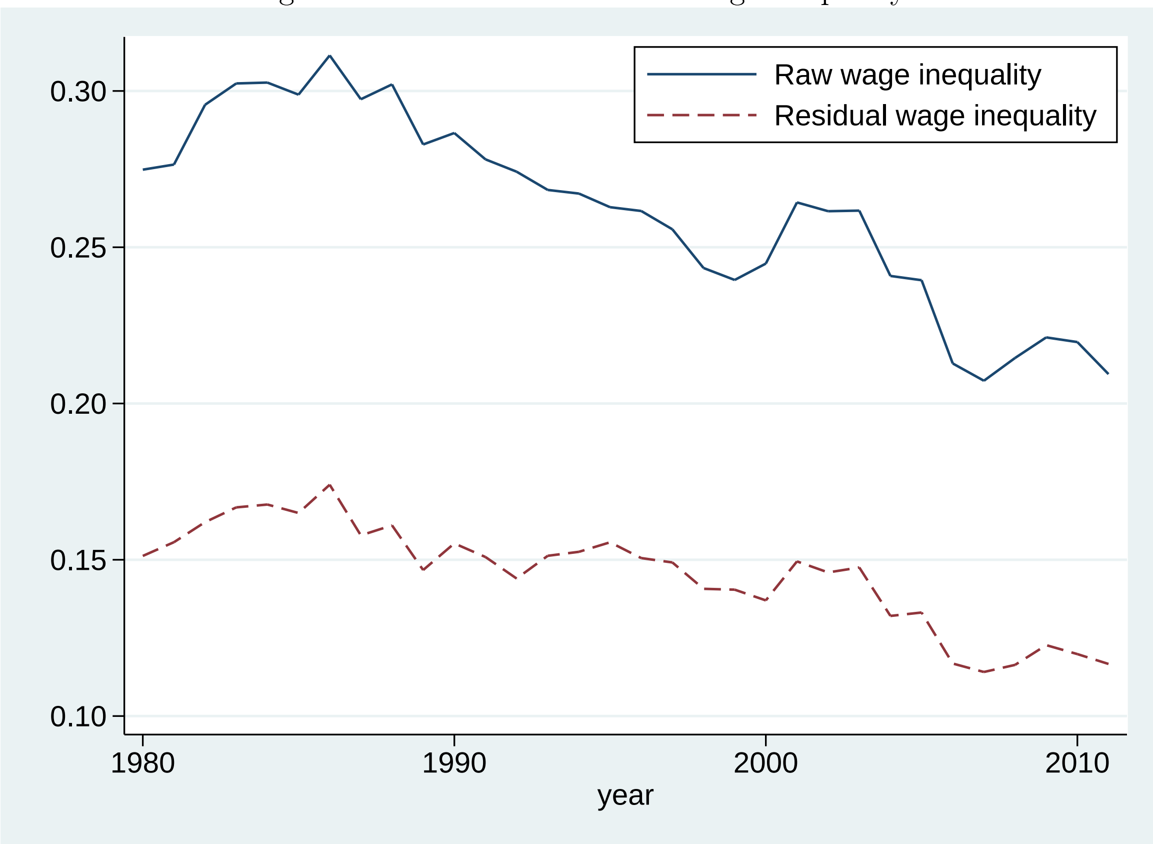
Note: The gender wage ratio is defined as the ratio between the average wage of male workers and that of female workers. The gender employment ratio is analogously defined. Data is from PPSHC and calculation is made by the author.

Figure 2.9: Gender Wage Ratio by Sub-groups



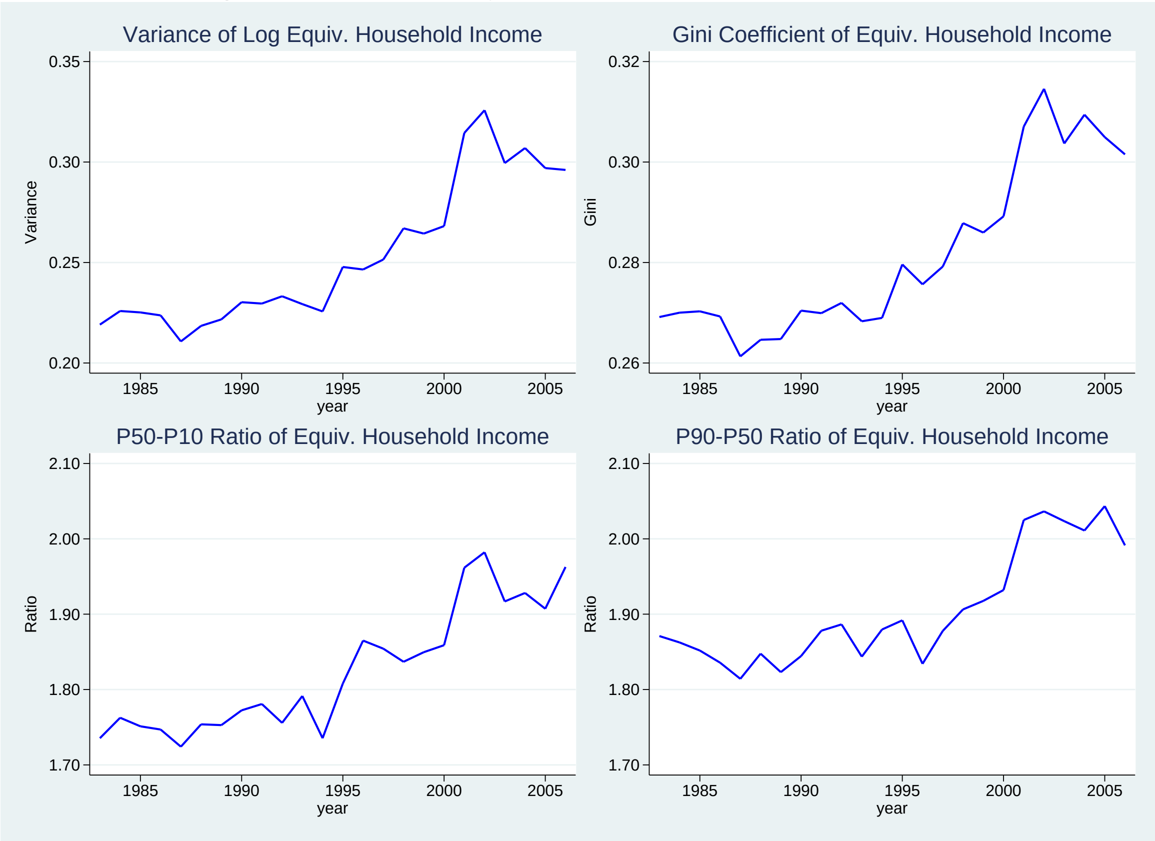
Note: The gender wage ratio in the college group is defined as the ratio between the average wage of college-educated male workers and that of college-educated female workers. Other ratios are similarly defined. Data is from PPSHC and calculation is made by the author.

Figure 2.10: Raw and Residual Wage Inequality



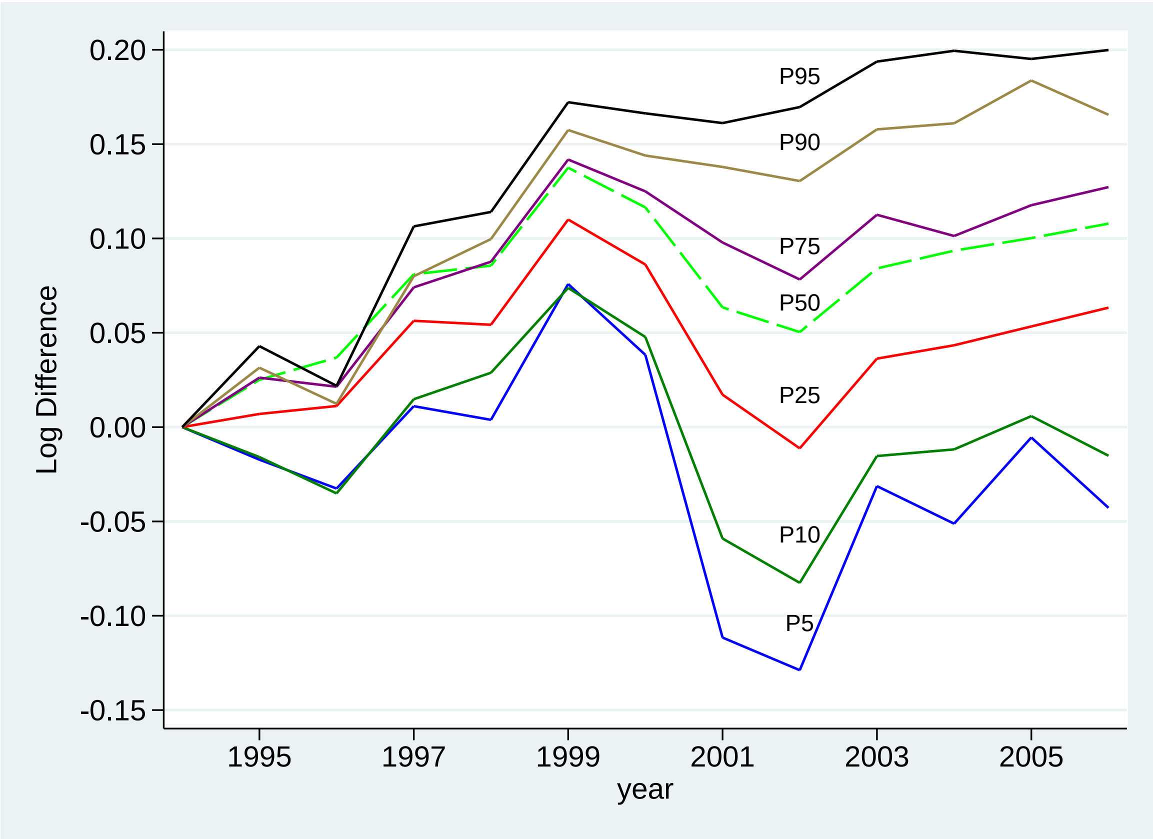
Note: The raw wage inequality is defined as the variance of log wage. The residual wage inequality is defined as the variance of log residual wage, which is the residual from regressing log wage on sex, education, age, work location and occupation. Data is from PPSHC and calculation is made by the author.

Figure 2.11: Inequality of Equivalized Household Income



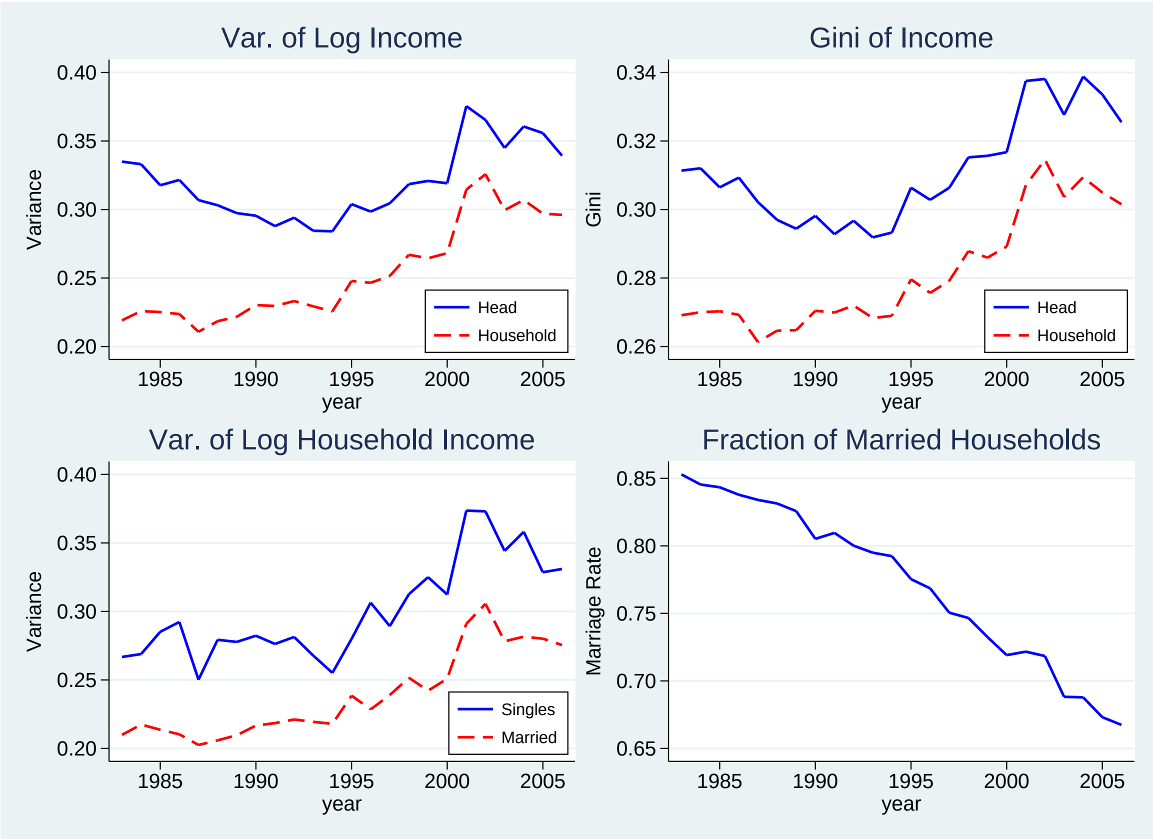
Note: Household-income is equivalized by OECD adult-equivalent scale, which assigns 1 to the first adult, .7 to each additional adult and .5 to each children. Data is from SFIE and calculation is made by the author.

Figure 2.12: Changes in Equivalized Household Income by Percentiles



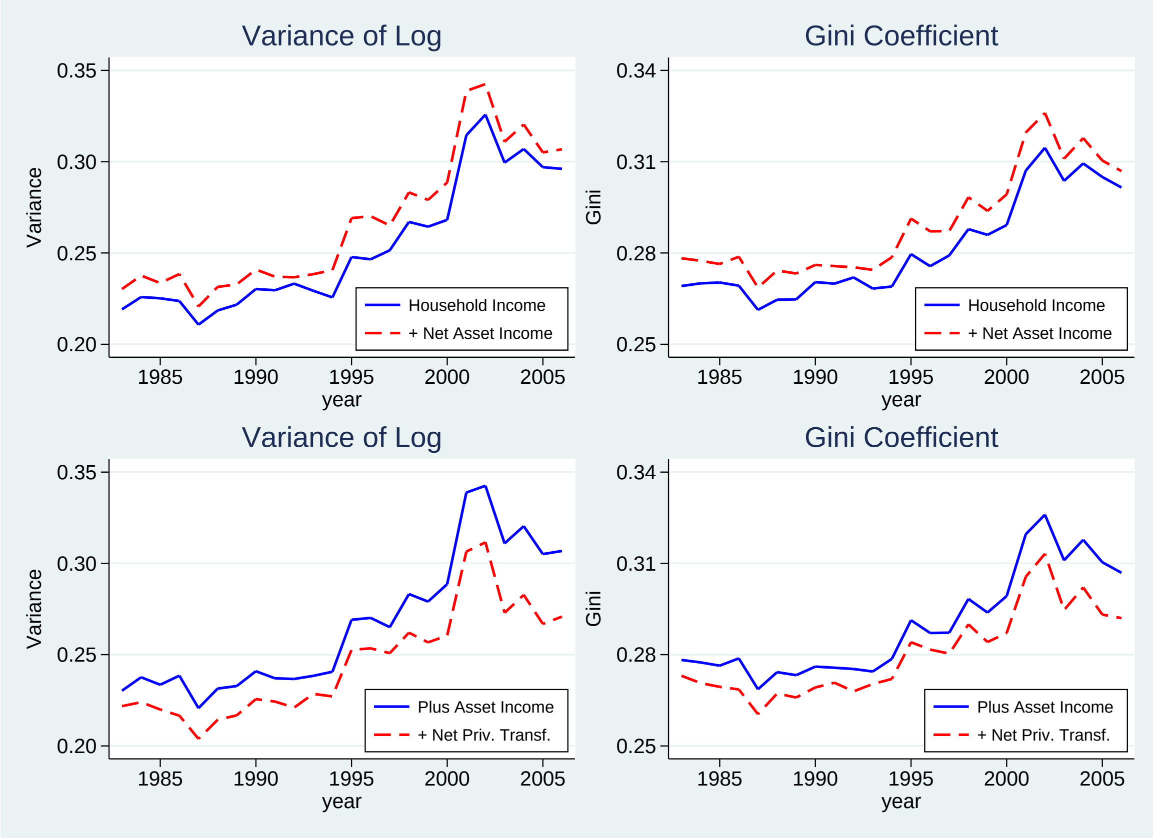
Note: For each household-income percentile, the figure shows the log difference against the level in 1994. Data is from SFIE and calculation is made by the author.

Figure 2.13: The role of Household Members in Reducing Income Inequality



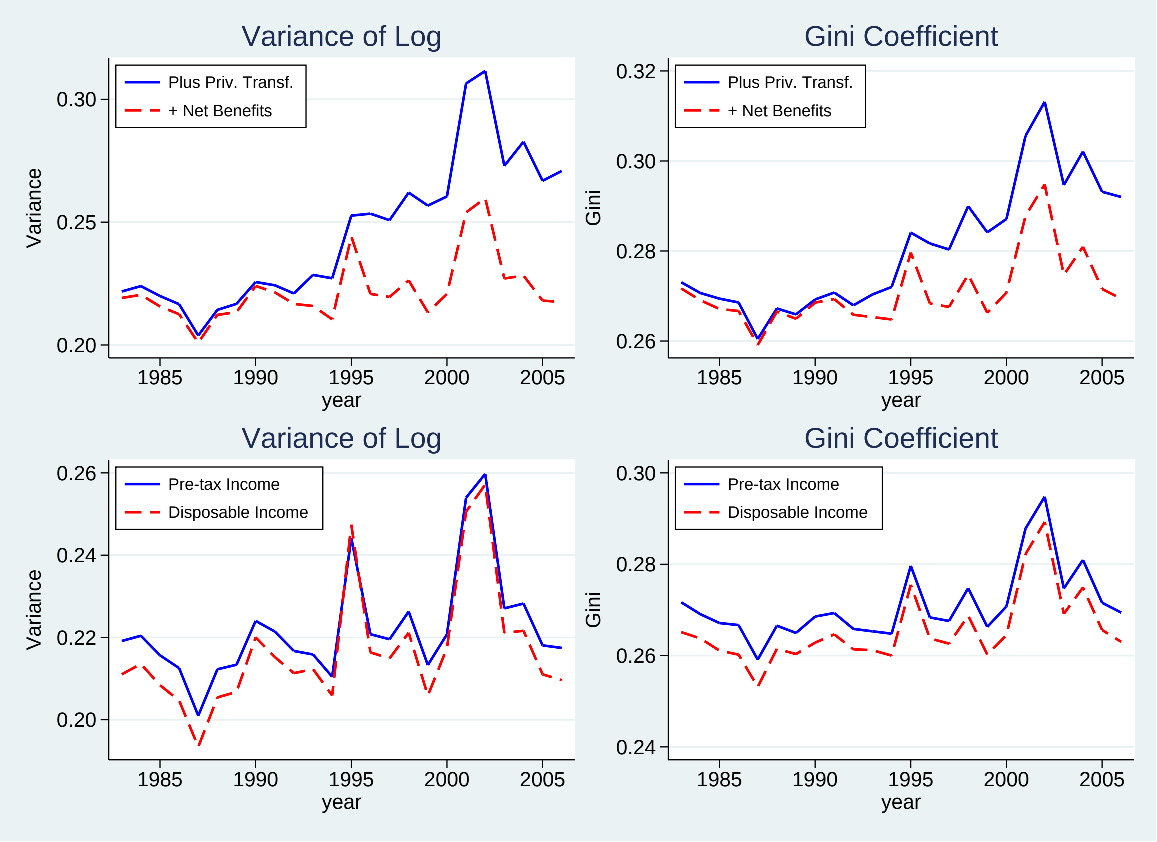
Note: Household-income is defined as household-head income plus labor income of other household members. Data is from SFIE and calculation is made by the author.

Figure 2.14: The influence of Asset Income and Private Transfers on Income Inequality



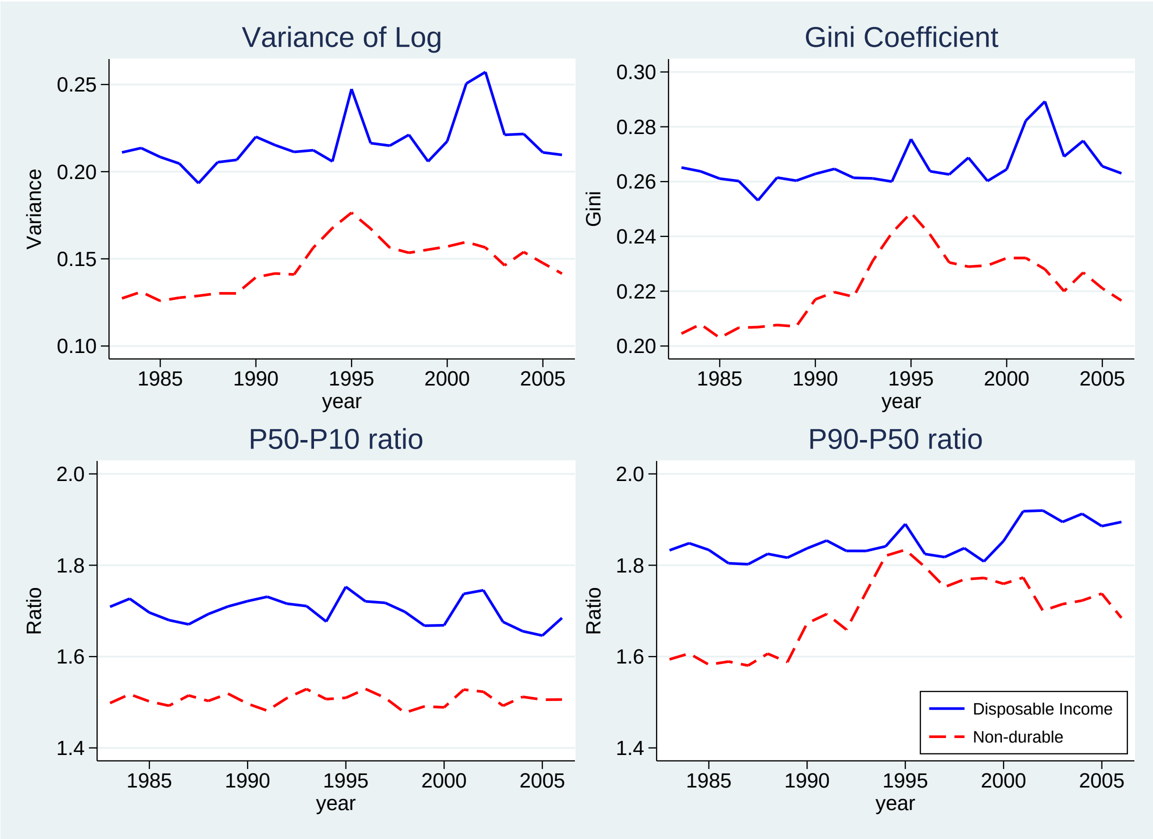
Note: The dashed lines in the top panels represent after-asset income, which is defined by household income plus net asset income. The dashed lines in the bottom panels represent after-private-transfer income, which is defined as after-asset income plus net private transfer income. Data is from SFIE and calculation is made by the author.

Figure 2.15: The Influence of Benefits and Taxes on Income Inequality



Note: Household-income is defined as household-head income plus labor income of other household members. Data is from SFIE and calculation is made by the author. Note: The dashed lines in the top panels represent after-benefit income, which is defined by after-asset income plus net cash benefits. The dashed lines in the bottom panels represent disposable income after taxes. Data is from SFIE and calculation is made by the author.

Figure 2.16: Disposable-income and Non-durable Consumption Inequality



Note: The solid lines represent the variance of log household disposable income and the dashed lines denote variance of non-durable consumption expenditure, which includes food, tobacco and alcohol, clothing, utilities, home non-durable, transportation and utilities, leisure and recreation, personal care and miscellaneous. Data is from SFIE and calculation is made by the author.

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