The Dissertation Committee for Wei-Pang Wang Certifies that this is the approved version of the following dissertation:

Education and Depression in Taiwan: Aging Trajectories, Cohort Variations, Mechanisms of Divergence, and Resource Substitution

Committee:

John Mirowsky, Supervisor

Mark Hayward

Catherine E. Ross

Wei-Hsin Yu

Tracie C. Harrison

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Wei-Pang Wang, B.A., M.A.

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Dedication

To my parents, Yen-Pin Wang and Chu-Yin Wu, and my sister, Wei-Ni Wang, for their unconditional love and support in my whole life.

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Education and Depression in Taiwan: Aging Trajectories, Cohort Variations, Mechanisms of Divergence, and Resource Substitution

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Wei-Pang Wang, Ph.D.

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Supervisor: John Mirowsky

A growing body of literature has elaborated the life-course and cohort patterns in the relationships between social factors and depression in Western societies. Nonetheless, far less research has focused on whether inequalities in social status have caused the inequality in misery over the life course in Eastern societies such as Taiwan, which is a collectivist society that has undergone tremendous social change. This research examines the life-course depression trajectories, with taking cohort variations into consideration, and assesses the multidimensional effects of education on depression in a network perspective. This study is based on the nationally representative samples from the repeated cross-sectional Taiwan Social Change Survey and from the longitudinal Survey of Health and Living Status of the Middle Aged and Elderly in Taiwan.

Results reveal a U-shaped aging trajectory in depression: depression declines in early adulthood, bottoms out in middle age, and then rises again in late life. This trajectory is the composite outcome established by factors associated with historical

trends in education, differential survivals, life stages, health decline, and maturity. Moreover, the direction of the trajectory depends on education. For the well-educated Taiwanese, depression decreases from early adulthood to middle life and maintains relatively stable in old age. For the less educated, depression increases steeply over the life course. Taken together, the education-based disparity increases with age and the pattern even strengthens across more recent cohorts, consistent with respectively the cumulative advantage theory and the rising importance theory. Although late-life convergence is found in cross-sectional analyses, aging vector analyses with FIML estimation and Gompertz survival analysis suggest that selective mortality is the plausible reason.

Meanwhile, education is not the only root cause of psychological well-being in Taiwan. Social relationships factors—such as children's education, co-residence, social support, and familial negative interaction—also demonstrate substantial influence on depression, but mediate educational effects slightly. However, in the aging vector analyses, education is the resource that consistently displays negative coefficients with respect to the slope of depression. Consistent with the resource substitution theory, educational effects are greater for those in disadvantageous statuses. Therefore, increased education is the most specific resource that suppresses the progression of depression over the life course and under difficult times.

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Chapter 1: Introduction

1. THE PURPOSE OF THE STUDY

Depression is the consequence of social inequality, not merely the personal demoralization that an individual deeply suffers. Depression chronicles the influence of social factors that have affected an individual's daily life throughout the life course. As a subjective state that an individual feels, depression essentially reflects the objective inequality in misery felt by individuals in the society. Nonetheless, whether social factors play a pivotal role in determining depression stratification in Taiwan has been rarely empirically investigated. Under what circumstances the impacts of social causes are more or less crucial in Taiwan than those displayed in the Western societies are also infrequently discussed. This research consequently proposes to establish the fundamental understandings of the social origins of depression in Taiwan and seeks to systematically examine the multidimensional effects of education, one of the core social causes of psychological distress. Moreover, this research aims to identify the unique Taiwanese phenomenon that might complement the existing paradigm of health sociology derived from the Western context.

Understanding the social causes of depression in Taiwan is of vital importance. In terms of practical aspects, the rising prevalence of depression is an emergent concern in Taiwan, especially among the elderly population. At the aggregate level, past psychiatric studies had reported that the prevalence is around 30% among people of old age (Chong et al. 2001; Tsai, Yeh, and Tsai 2005; Weinstein et al. 2004). At the individual level, research also indicated that depression increases in late adulthood in industrial societies (Mirowsky and Ross 1992). Since Taiwan is an emerging aging society as average life expectancy at birth peaks to 75.6 for males and 80.8 for females in 2006 (Executive Yuan

2007), depression may become a more apparent social problem in the near future. Hence, it is meaningful to establish sociological understandings of the social origins of depression to confront this imminent concern and even to influence the making of social policy.

Furthermore, in terms of theoretical aspects, as a newly industrialized country with distinguished cultural, social, and educational characteristics different from those commonly assumed in the Western countries, Taiwan provides a variety of intriguing properties that enable researchers to ascertain the multidimensional impacts of education on depression. To begin with, Taiwan is a distinct but ideal setting to evaluate the universal effects of education on depression. A tremendous body of Western research has unearthed that education is the consequential impact in structuring the inequality in distress over the life course (House, Lantz, and Herd 2005; Miech and Shanahan 2000; Mirowsky and Ross 2003b; Ross and Van Willigen 1997). Moreover, the most recent theory and findings discover that education is a specific resource that helps individuals effectively maintain psychological well-being and avoid depression exacerbation under difficult conditions, like when people are exposed to persistent high degrees of economic hardship. The reason that education benefits mental health is because formal education instills individuals with the inalienable problem-solving and resource-generating abilities that make individuals meet situations effectively, not because of the specific knowledge that individuals learned in the school or educational credentials that individuals truly accomplished (Mirowsky and Ross 2003b). Based on the above theory, regardless of the average levels of education in the society, individuals with more education years are less depressed and have less extent of depression deterioration during the periods of obstacles than their own counterparts with less education years. As a consequence, if the similar phenomena are found among the Taiwanese elderly population, where the average year

of education is less than 6 years and the educational content these elderly had received was plausibly substantially different from those in the Western education environment, the suggestion is that education provides universal inalienable ability to improve emotional well-being, whatever social or cultural backgrounds to which individuals belong are.

Second, Taiwan is a quintessential setting to study the social causes of depression in a network approach. The health literature that focuses on Western societies traditionally adopts an individualistic approach to model depression or other health outcomes as a function of one's own level of education or other social statuses (Zimmer et al. 2007) and generally regards education as the overall dominant cause that predicts both subjective quality of life and social relationships such as social support (Ross and Van Willigen 1997). Nonetheless, much less attention has been given to whether the depression patterns are shaped by familial factors such as family members' education or other familial resources or support. Taiwan is a society in which families are highly integrated, intergenerational transfers are usual, and family values are strongly emphasized. For instance, co-residence between the elderly and their adult children is not unusual. Children are involved substantially in their parents' daily life, even among non-co-residents (Hermalin 2002; Zimmer et al. 2007). Therefore, studying the patterns among socioeconomic status, social relationships and depression in Taiwan provides an unusual opportunity to evaluate whether these socioeconomic factors such as education still play a dominant role in determining the disparity in depression in the collectivist context and to assess the extent of impacts of the factors associated with social networks—such as adult children's education levels, co-residence, marital status, social support, and familial negative interaction—on depression itself and on the relationships between education and depression.

Third, Taiwan is a society that has undergone dramatic social change in the last century, as highlighted by aggregate increases in education—the proportion of receiving at least a junior college degree among the population aged 15 and over has expanded from 5.5% to 24.4% between 1970 and 2000 (Executive Yuan 2000)—and improvement in overall social and demographic environments such as those discussed in later chapters. Taiwan is therefore an excellent setting to observe whether the life course patterns between education and depression vary across birth cohorts, which is also a research theme rarely discussed in Western societies.

On the foundation of these distinctive characteristics, it is essential and meaningful to study depression and its social causes in Taiwan to enrich the knowledge of social inequality in depression. The following section introduces the framework of this study and previews the main hypotheses to be empirically assessed.

2. THE PREVIEW OF THE RESEARCH AGENDA

This dissertation is composed of seven chapters including introduction (Chapter 1). Chapter 2 presents the overview of the theoretical background and Chapter 3 introduces data, measures and methods. Furthermore, Chapter 4, Chapter 5, and Chapter 6 analyze the major research themes incorporated in this study, according to the general to specific order. Last but not least, Chapter 7 concludes the overall findings.

Chapter 4, including two major sections, is designed to denote the prototypical social patterns of depression over the life course in Taiwan. First, this chapter ascertains six cross-sectional samples with different age structures in both substantive and statistical terms to establish a composite picture of depression patterns across the life course. The second section examines five classic aging theories (Mirowsky and Ross 1992) that explain the change of average levels of depression by age: *aging as historical trends*

perspective suggests that average levels of depression are higher in old age because older Taiwanese belong to cohorts with less average levels of education; *aging as differential survival perspective* argues that decline and growth in depression by age depend on different traits associated with survival. Depression itself and the risk factors of depression such as low socioeconomic backgrounds increase mortality, which leads to progressively decline in average levels of depression in successively older age groups. On the other hand, average levels of depression increase among the elderly population because females are more depressed but survive longer; *aging as life stage perspective* hypothesizes that depression declines from early adulthood to middle adulthood because of the development of marital, employment, and economic statuses, while depression rises again in old age as a consequence of the loss of resources and social roles through retirement and the loss of spouse; *aging as decline perspective* advocates that the increasing prevalence of physical impairment and chronic diseases and the increasing levels of powerlessness accelerate the growth of depression in successively older age groups; and *aging as maturity perspective* implies that depression decreases in old age because the elderly are more mature to handle social relationships and have greater satisfaction.

Chapter 5 integrates the life-course and cohort perspectives to investigate whether education differentiates aging trajectories of depression in Taiwan. Three reasons underscore the importance of studying the aging effects and the cohort effects concurrently on the educational-based disparity in depression. First, it is plausible that the life course patterns in depression vary across cohorts since Taiwan is a society that has experienced rapid social change. Second, the ignorance of cohort effects might amount to biased estimation and sometimes even completely incorrect conclusions of the life course trajectories in health studies (Lauderdale 2001; Lynch 2003). Third, empirical analyses

that ascertain the temporal relationships between education and depression are not only rare but also reveal inconsistent results (Mirowsky and Kim 2007; Yang 2007). This study hence gauges three theories that explain temporal education-health patterns, which have caused tremendous debate over the last 20 years, including *the cumulative advantage hypothesis* that predicts that the educational-based differential in health strengthens with age; *age-as-lever hypothesis* that anticipates disparity in health across levels of education increases through much of adulthood but eventually converges in later life; and *the rising importance hypothesis* that expects the rate of the educational-based divergence in health is larger for younger cohorts (Lauderdale 2001; Lynch 2003, 2006; Miech and Shanahan 2000; Ross and Wu 1996). Moreover, this research argues that the direction of the aging trajectories differs across levels of education in Taiwan and presents *reversed trajectory hypothesis*.

Chapter 6 is designed to examine the specific effects of education on sustaining stable psychological well-being over time and to analyze whether the strength of education-depression association depends on other advantageous or disadvantageous statuses. Two theories are tested, including *the resource substitution hypothesis* that proposes education's influence on depression is greater for individuals with limited alternative resources in economic or social aspects than it is for their counterparts with more resources, and *the resource multiplication hypothesis* that asserts the effect of education on depression is greater for the more advantaged in economic and social resources (Mirowsky and Ross 2003a; Ross and Mirowsky 2006). With the utilization of the aging vector model on panel samples, as detailed in Chapter 3, the different effects of education by different statuses in economic and social resources on the initial level and the individual's average annual change of depression are differentiated and clearly displayed.

In particular, Chapter 6 examines two sets of resources. The first part centers on the relationships among education, economic resources—such as economic hardship, income, occupation prestige, employment status, work and economic satisfaction, investment, and received economic assistance—and depression over the life course in Taiwan. To begin with, this research reexamines *the economic mediating pathway* that asserts that the well educated have better emotional well-being because they are less likely to be exposed to stressors associated with disadvantageous statuses in economic resources (Krause and Shaw 2002b; Ross and Van Willigen 1997; Schieman, Van Gundy, and Taylor 2001) by taking into account the temporal patterns in economic resources such as rising economic hardship or falling economic hardship over time into the analyses. Furthermore, whether people with limited economic relationships—such as persons experiencing persistent high economic hardship—gain more psychological benefits from education, is gauged. The second part aims to disentangle the relationships among education, social relationships, and depression in Taiwan. The empirical evidences based on the Western population declares *the social relationship mediating pathway* expecting people with higher levels of education are less depressed because they tend to have supportive relationships that benefit health and avoid conflictive relationships, criticism exposure or dissatisfaction that damage health (Krause and Shaw 2002b; Ross and Van Willigen 1997; Schieman, Van Gundy, and Taylor 2001).

Nonetheless, whether education is still the overall dominant determinant of depression in the collectivist society of Taiwan remains a mystery. Two perspectives are evaluated, *the dominance and protectiveness hypothesis* means that education is not only an overall root factor that structures both better economic environment and positive social relationships that benefit psychological well-being, but also influences depression notably on its own, while *the independence but protectiveness hypothesis* suggests that education

and social relationships display independent effects on depression in the collectivist society of Taiwan, although education is still a particular resource that influences the slope of depression change over time. Among social relationships factors, the effects of children's education levels and the impacts of negative interaction on depression are especially underscored.

3. THE METHODOLOGY OF THE STUDY

Taiwan is a society that has experienced tremendous social change. Accordingly, this research adopts multiple quantitative methods on various types of data sets with different age and cohort structures to capture a more complete image of depression patterns in Taiwan. Conventionally, this study first uses the descriptive statistics and the cross-sectional analyses on data drawn from the repeat cross-sectional data from the 1990, 1995, 2000, and 2005 *Taiwan Social Change Survey* (TSCS hereafter) and on data from the baseline samples of the longitudinal data from the *1989, 1993, 1996, 1999, and 2003 Survey of Health and Living Status of the Middle-Aged and Elderly in Taiwan* to describe the basic patterns of depression over the life course and to further demonstrate the disparity in depression by levels of education. Subsequently, this study utilizes the standard age-cohort regression model (Lynch 2003) on the pooled TSCS data and the latent growth curve model (LGM) with aging vectors techniques (Mirowsky and Kim 2007; Mirowsky and Ross 2007) on the longitudinal middle-aged and elderly data across 14 years to delineate both aging and cohort effects on the relationships among education, economic resources, social relationships resources, and depression over the life course.

In particular, the aging vector model provides a clear advantage over traditional regression methods. First, it is a two-level model estimating within-person changes in outcomes—such as depression in this study—over time and between-person differences

in these change (trajectories). In other words, this approach enables researchers to distinguish mean differences in outcomes that are attributable to between-person differences versus changes within individuals across the life course. Second, mortality selection usually biases the estimation of the mean between-person difference in outcomes in the traditional approach (Lynch 2003). In the aging vector model, researchers are able to estimate the trajectories for individuals with limited information according to their available observation with the utilization of estimation methods such as full information maximum likelihood (FIML) approach (Mirowsky and Kim 2007; Mirowsky and Ross 2007). Mortality selection bias is thus lessened.

Moreover, the aging vector is an analytical approach that facilitates the distinction between aging effects and cohort effects in the temporal patterns of depression across social statuses. As mentioned earlier, Taiwan is a setting that has undergone dramatic social and demographic change over the last 60 years. This specific characteristic makes it difficult for researchers to estimate or conclude any social patterns related to the concept of temporality such as aging trajectories and cohort variations. Inconsistent findings may be found across samples with age compositional differences. The confounding effects of age changes and birth cohort differences are impossible to be empirically disentangled in the cross-sectional analyses and often aggravate ambiguity (Yang 2007). The utilization of the aging vector model on the panel samples enables this study to investigate whether the origins and slopes of change of depression is stratified by levels of education during the follow-up period as functions of age at the time and to capture and reveal inter-cohort trends. It thus effectively eliminates the above frequently occurring ambiguity in the cross-sectional analyses. Likewise, the within-person level and the between-person levels of heterogeneity in estimating mean differences in outcomes are able to be distinguished and be correspondingly graphed—as detailed in the

later chapters—to visualize whether the temporal pattern eliminates or augments after adjusting other factors and whether the strength of the pattern is contingent on these factors.

Chapter 2: THEORETICAL BACKGROUND

Three major sections are incorporated into this chapter. The first section reviews five aging aspects that enable this research to establish the foundational understandings of the aging trajectories in depression in Taiwan. The next section presents three sets of theories designed to explain the multi-dimensional relationships between education and depression in the Western paradigm. The third section summarizes the integrated hypotheses with taking the Taiwanese context into consideration.

1. DEPRESSION ACROSS THE LIFE COURSE

Depression is an unpleasant subjective state that takes a form of gradations in the emotional mood and in the physiological malaise. Health sociologists advocate that depression and well-being are opposite ends of the same continuum, rather than the discrete categories as "non-depressed" and "depressed" titled in the diagnostic approach. In other words, depression—not alienation or mental illness—is the realistic demoralization that every individual in the society feels (Mirowsky and Ross 2003b). Depression is universal among all humans and occurs at every stage over the life course. The question is to suffer more or less.

The five theoretical views of age—age as historical trends, age as differential survival, age as life stage, age as decline, and age as maturity (Mirowsky and Ross 1992) are regarded as the classic conceptual framework for the study of depression trajectories over the life course (Miech and Shanahan 2000; Schieman, Van Gundy, and Taylor 2001; Yang 2007). These aging views are not mutually exclusive. These effects are coincident and coexistent and affect depression concurrently. A substantial body of empirical research has indicated that these views effectively explain the composite U-shape

relationships (or the J-Shape relationships, when the samples include the oldest old) between age and depression found in the cross-sectional samples. That is, middle-aged adults feel less depressed than younger or older adults (though the oldest old feel less depressed again) (Kessler et al. 1992; Mirowsky 1996; Mirowsky and Reynolds 2000; Mirowsky and Ross 1992). Although these aging perspectives are designed to examine the patterns across the overall adulthood in the cross-sectional samples, their core concepts still enable the study of late-life depression (Yang 2007) and are embodied in the statistical models designed to analyze panel samples (Kim 2006; Mirowsky and Kim 2007; Mirowsky and Ross 2007). As a consequence, this study utilizes these five aging views as a blueprint to build up the basic understandings of depression trajectories by age in Taiwan.

1) Age as Historical Trends

The "age as historical trends" hypothesis suggests that at any given age the older people have higher average levels of depression because they belongs to a generation with less education and have experienced unfavorable historical times. The growth of depression in old ages hence partially reflects differences across cohorts rather than the internal development in depression over the life course.

The rapid social transformation of Taiwan implies that the Taiwanese elderly have undergone tougher historical circumstances. Aggregate increases in education underlines the tremendous overall social change over the last 60 years. The proportion of receiving at least a junior college degree among the population aged 15 and over has expanded from 5.5% to 24.4% between 1970 and 2000 (Executive Yuan 2000). Meanwhile, crude birth rate (‰) has dropped from 25.93 in 1976 to 9.06 in 2005, and average life expectancy at birth for males and females has improved from 57.4 and 60.3

in 1952 to 75.6 and 80.8 in 2006, respectively. Taiwan has also transformed from an agricultural economy to an affluent and industrial one. Per capita gross national product (GNP) has increased from 145 USD in 1951 to 16,098 USD in 2006 and the percentage of the labor force in agriculture has plummeted from 55.5% in 1956 to 8.5% in 2000 (Executive Yuan 2000, 2007). A strong medical and health care system has been established, marked by the National Health Insurance (NHI) program launched in 1995, which is a comprehensive medical service for the entire Taiwanese population (Bureau of National Health Insurance 2006). Also, infectious diseases have almost been eradicated and chronic diseases such as malignant neoplasm has became the leading cause of death (Executive Yuan 2007).

Additionally, the Taiwanese elderly are the generations who had encountered the historical turmoil around World War Two, regardless of ethnicity[1]. For the Holos, Hakka, and Aboriginals elderly (so called Taiwanese and hereafter), they had received Japanese education in the relatively stable Japanese colonial period (1895-1945) but needed to adjust to the totally different political and social system since the arrival of Chiang Kai-shek's Nationalist government (Hsiau 1997; Luoh 2001b). On the other hand, Mainlanders—the influx of about 1.5 millions Mainlanders came to Taiwan from Mainland China when the Nationalist army lost the Chinese Civil War in 1949–represent the cohorts who had received Chinese education and had spent their early adult lives

[1] Four ethnic groups in Taiwan.

Ethnic groups	Migrated from China to Taiwan since	% of total population in 2000 (2,300 millions)	Mother Tongue
Holos	17th Century	70%	Holos Chinese (usually called Taiwanese)
Hakka	18th Century	13%	Hakka Chinese
Chinese Mainlanders	World War Two	15%	Mandarin Chinese
Aboriginals	Native Taiwanese, over 10 races in this category	2%	Diverse Austronesian Languages

under war conditions and most of their adult life away from their hometown (Executive Yuan 2007; Luoh 2001a).

In sum, the "age as historical trends" hypothesis suggests that average levels of depression are higher in old age, and adjusting for favorable trends toward younger generations—such as levels of education, levels of children's education, levels of financial investment—accounts for some of the association.

2) Age as Differential Survival

Aging predicts both decline and growth in the average levels of depression over the life course, contingent on different traits associated with survival. On the one hand, decline in depression may be a false impression due to mortality selection. Being older improves the likelihood of having characteristics associated with survival. Taiwanese with more education and more economic or social resources are not only less likely to be depressed but also have lower risks of dying (Beckett et al. 2002; Liang et al. 1999; Zimmer, Martin, and Chang 2002). The elderly population is thus full of selected less-depressed and healthier individuals. Aging hence seems less depressing than it is. On the other hand, Taiwanese female are more depressed but live longer (Executive Yuan 2006; Liang et al. 1999). Average life expectancy at birth for males and females are 75.6 and 80.8 in 2006, respectively (Executive Yuan 2007), aging hence appears more depressing than it is, which tends to offset the other survival effects.

As a consequence, the first form of the "age as differential survival" hypothesis is that depression declines with successively older age groups, and the adjustment for socioeconomic and marital status accounts for some falling aging curve, while the second form suggests that depression increases in old age, and adjusting for sex explains some of the rising curve.

3) Age as Life Stage

Age is a sequence of life course stages that depicts individual progression in achieved status such as marital, economic, and employment statuses that mirror fall and rise in depression. Most Taiwanese begin their early adulthood single, in school or recently graduated, and partially depend on their family for financial support. The progression to middle age increases the likelihood of marriage, employment, and higher levels of income, all of which reduce depression. Nevertheless, retirement and loss of spouse cause steady disengagement from economic and social resources and eventually lead to the growth of depression in late life. Taken together, the "age as life stage" hypothesis expects that average levels of depression decrease from early adulthood to middle age and then rise with older age, and the adjustment of marital and economic statuses eliminates some parts of the falling and rising trajectories.

4) Age as Maturity

Age implies the summation of growth of insight, self-integration, experiences, skills, and self-esteem. People in successively older age groups are more likely to live in a more routine and orderly life and less likely to be influenced by external incidents. Moreover, with age, individuals are more likely to handle social relationships well and avoid negative inter-personal relationships. All of the above characteristics suggest a parallel decline in depression with age. As a result, the "age as maturity" hypothesis anticipates that average levels of depression decrease in successively older age groups, and the adjustment of negative interaction and relationships dissatisfaction partially explain the falling aging curve in depression.

5) Age as Decline

It is human nature that the elderly encounter accelerating decline in physical health and face higher risks of the onset of chronic diseases. Meanwhile, the diminution of sense of control parallels the decline of physical health. All of these factors lead to a surge in depression in later life. Therefore, the "age as decline" hypothesis says that average levels of depression increase at an accelerating rate in progressively older age groups, controlling for physical impairment, chronic diseases, and sense of control account for some of the age variations in depression.

2. THE OVERVIEW OF EDUCATIONAL EFFECTS ON HEALTH OR DEPRESSION IN THE WESTERN PARADIGM

The association between education and health is one of the most important interests in the sociology of health and illness (Beckett 2000; Elo and Preston 1996; Herd, Goesling, and House 2007; House et al. 1994; Ross and Wu 1995). Education is traditionally regarded as the fundamental cause of diseases and nourishes physical health and psychological well-being via the incorporation of economic and social relationships mediators (Miech and Shanahan 2000; Ross and Van Willigen 1997; Turner and Lloyd 1999). The latest empirical findings suggest that the effects of education on health are beyond the scope of the mediating mechanisms via economic and social relationships resources. Education is not only a resource itself but also the learned effectiveness that education instills into people, which helps individuals find a way to accumulate resources that enhance health (Kim 2006; Mirowsky and Ross 2007). These two perspectives are inherently connected. Yet, the different aspect that each emphasizes reinforces the debate between two temporal theories in the relationships between education and physical health

or depression. The age-as-lever theory suggests that biological effects eventually replace the social effects—resources provided from socioeconomic statuses decline in old age as individuals enter the stage such as retirement—and leads to the shrinking of educational-based inequality in health in late adulthood. The cumulative advantage theory emphasizes that the benefits of education on health are cumulative and self-amplifying, providing a widening educational-based gap in health across age (Herd 2006; House, Lantz, and Herd 2005; Lynch 2003; Mirowsky and Ross 2003a). Meanwhile, the latest studies shed new light on the appraisal of cohort heterogeneity in educational effects on depression (Lynch 2003) and on the assessment regarding whether the strength of the association between education and depression depends on other social statuses (Kim 2006; Ross and Mirowsky 2006).

The following section recapitulates these interrelated theories derived from the Western paradigm, according to the general to specific order.

1) Education as a Fundamental Cause

Socioeconomic status (SES) is the fundamental cause of diseases that not only structures individuals' exposure to risk factors but also determines individuals' access to resources that help them avoid diseases or eliminate diseases' negative outcomes (Link and Phelan 1995; Phelan et al. 2004). Among SES indicators, education is the most powerful and stable one. Methodically speaking, education shapes other SES indicators such as income. Education can be determined for all individuals in the sample. Education is also generally stable after early adulthood and usually unaffected by health in later life (Mirowsky and Ross 2003a). Empirically speaking, education associates with higher levels of self-reported health and physical functioning (Lantz et al. 1998; Lantz et al. 2001; Mirowsky and Ross 1998), lower rates of mortality (Elo and Preston 1996; Pappas

et al. 1993), lower levels of depression, anxiety, malaise, pain and ache (Ross and Van Willigen 1997), and the course of anger (Schieman 2000).

Moreover, education is regarded as the essential factor that determines whether people live in the era of "compression of morbidity" or the time of "longer life but worsening health" (Fries 1980; Verbrugge 1984). Specifically, prior research has suggested that the well educated are increasingly experiencing postponement of morbidity and disability into a brief period in the last years of life. Conversely, the poorly-educated are encountering earlier onset of morbidity and disability and facing steep deterioration in health throughout their entire adult life course (House, Lantz, and Herd 2005; House et al. 1994). Education is hence a crucial indicator of "successful aging" (Rowe and Kahn 1997a). However, whether the temporal educational effect extends to mental health such as depression and anxiety remains substantially unexamined (Miech and Shanahan 2000).

Research over the last decade has effectively explained the pattern between education and depression via the incorporation of mediators (Turner and Lloyd 1999). In other words, the mechanisms by which education affects psychological well-being and whether education's effect extend beyond these mechanisms, are well investigated (Miech and Shanahan 2000; Ross and Van Willigen 1997). The economic resource pathway and the social relationship pathway are two of the most fundamental mechanisms.

Economic Resource Pathway

Education structures economic insufficiency, which in turn influences variations in exposure to stressful circumstances or chronic stressors (Miech and Shanahan 2000; Turner, Wheaton, and Lloyd 1995). In other words, the well educated tend to have better

psychological well-being because they are less likely to be associated with economic hardship, unemployment, lower income, and lower occupational class (Ross and Van Willigen 1997). The lack of economic resources not only causes material deprivation but also diminishes the problem-coping resources such as a sense of control, both of which increase psychological distress (Mirowsky and Ross 2003b).

Among those economic factors associated with education, economic hardship—difficulty in paying bills or meeting the household needs for food, clothing, shelter, or medical care—is the prominent one affecting mental health. Economic hardship is the day-to-day struggle to meet basic human needs. It reflects whether people recurrently engage in chronic stressors that affect their mental health intensely (Aneshensel 1992). In fact, economic hardship mediates the substantial part of the effects of income or earnings on depression or physical health. Once needs are met or hardships are solved, the increments of other economic resources display diminishing effects on health (Mirowsky and Hu 1996; Ross and Huber 1985). Moreover, the effects of the temporal category of economic hardship on depression have gradually been discussed. Research has indicated that persistent or new economic hardship over survey periods affect depression, but not resolved economic hardship does not (Mirowsky and Ross 2001). However, whether the education-depression pattern is contingent on the temporal pattern of economic hardship remains unexamined.

Social Relationship Pathway

Education shapes variations in supportive relationships, which is one of the most important coping resource that ameliorates depression (Ross and Van Willigen 1997). In essence, social support represents the sense of having someone who cares and will help if needed, including instrumental support such as providing transportation, and emotional

support such as being cared about, loved, esteemed, and valued as a person (Cornman et al. 2003b; House 2001; Mirowsky and Ross 2003a; Pearlin 1989; Ross and Mirowsky 2002; Ross, Mirowsky, and Goldsteen 1990; Rowe and Kahn 1997b). The supportive relationship not only influences depression directly but also buffers the negative impacts of stressful life events or chronic difficulties in a person's life.

Conversely, the conflicting relationship full of dissatisfaction or negative interactions—unpleasant encounters such as criticism, daily hassles, or excessive demands—are regarded as a form of chronic strain that deteriorates psychological distress by eroding feelings of self-worth and offsetting the benefits of social support (Krause and Rook 2003b; Schieman, Van Gundy, and Taylor 2001). Although levels of exposure to negative interactions are not always greater for low-educated elders, a lack of the sense of control and coping resources may make elders with poor education more vulnerable to the adverse effects of negative interactions on health (Krause and Rook 2003a; Krause and Shaw 2002a).

Additionally, education is positively associated with being married but inversely associated with the loss of spouse—a common stressor that affects depression at older ages (Miech and Shanahan 2000). The well educated tend to have a more supportive and satisfying marriage because they commonly marry later in adulthood under more stable economic conditions and have better cognitive capacities to understand and negotiate with their mates adequately when facing marital risks (Mirowsky and Ross 2003a; Ross and Willigen 1997). Marriage generally decreases economic hardship and provides social support, both of which eliminate depression (Mirowsky and Ross 2003a, b; Ross 1991; Ross and Mirowsky 2002; Ross, Mirowsky, and Goldsteen 1990; Ross and Willigen 1997; Umberson 1987, 1992; Waite 1995). The loss of spouse thus symbolizes the loss of health-enhancing resources.

2) The New Mechanisms Between Education and Depression

The human capital perspective suggests that education plays a crucial role in improving emotional well-being because education is a resource itself and the human capital that helps individuals find a way to generate other resources. Based on this assumption, the resource substitution theory and the resource multiplication theory are developed to examine whether the strength of the association between education and depression depends on other social statuses (Kim 2006; Ross and Mirowsky 2006). In other words, are the effects of education more important among individuals with more resources or not?

Human Capital Theory and The Sense of Control

Human capital theorists contend that formal education represents an investment in human capital, the productive capability developed, embodied, and stocked in human beings themselves (Schultz 2000). Through education people gradually develop the inalienable internal ability to learn and think rationally, communicate effectively, analyze data, solve problems, implement plans, organize resources, and integrate information. Moreover, during the process of education pursuit, assignments or exams people encounter are progressively complex or difficult. More the years of schooling people attend, the more difficult challenges people will eventually accomplish. Therefore, the well educated accumulate more successful experiences of difficult problem solving, develop greater cognitive ability, and establish higher confidence, habits and motivation to attempt to resolve problems. More importantly, these inherent cognitive abilities and values boost the well-educated people's higher levels of sense of control, which refers to

the higher learned belief that an individual can master or alter one's own outcomes. Higher levels of sense of control enable people to achieve effective means toward a health-enhancing lifestyle and create new ways to ameliorate or overcome any health crisis. The sense of control also shapes the stable psychological well-being, even for the person who experiences the most difficult times. On the contrary, low-educated people tend to have lower sense of control because they may meet continued failures from the previous educational frustration and the following restricted socioeconomic circumstances (Coleman 1988; Mirowsky and Ross 2003a; Rowe and Kahn 1997b; Schultz 2000; Seeman and Lewis 1995; Sen 1997; Winkleby et al. 1992).

The assumption of the human capital perspectives becomes the core element of the following competing theory: resource substitution or resource multiplication?

Resource Substitution

In general, resource substitution refers to the phenomenon that people with more resources are less dependent on the presence of any specific resource for their psychological well-being. In other words, if a certain resource is absent, people with more resources can utilize other alternative resources to replace that lost resource. Conversely, people with the fewest resources are most dependent on any one resource they have for their psychological well-being. The absence of any resource makes their life more critical since they have no other ones to substitute (Mirowsky and Ross 2003a).

Two characteristics make education a particular resource that effectively substitutes other absent resources. First, education instills people with human capital—the general ability to learn, think, and meet situations effectively. Second, a person's education is part of the person and is inalienable. It is not like the external SES status such as income or a job, which can be taken away (Mirowsky and Ross 1998; Ross and

Mirowsky 2006). Education's effect exists in every stage of the life course and is able to substitute other external resources. For instance, elderly people tend to suffer from the loss of economic and social relationship resources due to retirement and loss of spouse. The presence of education probably makes the absence of these social resources less deleterious (Miech and Shanahan 2000; Schieman, Van Gundy, and Taylor 2001). In sum, the resource substitution theory predicts that education's effects are greater for people with disadvantageous status (Ross and Mirowsky 2006).

Resource Multiplication

In contrast to resource substitution, resources multiplication proposes that the multiple resources of the advantaged group multiply each other to perpetuate and augment their benefits. For instance, people from privileged backgrounds tend to enter college with high prestige, which eventually reproduces social inequality. Thus, certain resources have stronger effects on health in the advantaged group (Ross and Mirowsky 2006).

Accordingly, elderly who are advantaged in economic or social relationship resources—such as those with higher economic resources or with a spouse—have greater emotional benefits from education. These different types of resources reinforce each other. This situation implies that education's benefits for well-being are less for elderly with higher economic hardship or widowhood than those for their counterparts. In sum, resource multiplication implies that people with disadvantaged status gain less psychological benefits from education.

3) The Temporal Pattern Between Education and Depression

The life-course patterns between education and physical health or mortality are one of the most important debates over the last couple of decades (House et al. 1990; House et al. 1994; Ross and Wu 1996). With the release of new-collected panel samples and the development of quantitative methods, this topic receives more and more attention. Recent studies even developed the innovative approaches to distinguish the confounding aging and cohort effects (Beckett 2000; Dupre 2007; Herd 2006; Herd, Goesling, and House 2007; House, Lantz, and Herd 2005; Lynch 2006; Mirowsky and Ross 2007). Three theories—the cumulative advantage theory, the age-as-lever theory, and the rising importance theory—are established based on the study of physical health or mortality and have also been gradually developed to elaborate the temporal pattern between education and depression. It is not unreasonable to extend these physical health-orientated theories to mental health studies because psychological distress often takes physical form. Besides, physical health problems substantially lead to elevated depression (Kim 2006; Miech and Shanahan 2000; Ross and Van Willigen 1997).

Cumulative Advantage Hypothesis

The cumulative advantage hypothesis predicts that health disparity across levels of education increases in old age. The concepts of cumulative advantage were originally proposed to explain the growth of economic heterogeneity in adulthood (Crystal and Shea 1990; O'Rand 1996), and then extended to the study of health (Ross and Wu 1996). According to this theory, education structures resources that cumulate throughout life, producing a widening educational-based gap in health across age. The core element of this theory is that education is not only a resource itself but also instills greater effective abilities, habits, and attitudes, all of which make individuals better at avoiding the onset

of health problems and better at self-controlling or self-managing when health problems occur. Moreover, the well educated tend to have higher income and better work environments. In contrast, the poorly educated are more likely to encounter the stress of economic hardship or alienated work. A lack of economic resources among these poorly educated even makes it difficult to escape from negative impacts of economic hardship or to switch to jobs with beneficial work characteristics such as higher autonomy. The negative outcomes resulting from these economic disadvantages are usually exacerbated over time. In addition, lower education associates with unhealthy lifestyle such as smoking, which requires a long duration of exposure to produce poor health (Mirowsky and Ross 1998; Pincus et al. 1998; Ross and Wu 1995, 1996). These health-improving resources influence mental health either directly through their own cumulative effects or indirectly through their impacts on physical health (Miech and Shanahan 2000).

Taken together, health-enhancing resources are accumulated that disproportionately benefit those with higher education over time, which produces a diverging gap in health (Mirowsky and Ross 2003a). The empirical evidences for education's cumulative advantages have been found for physical health and self-reported health (Ross and Wu 1996), relative survival (Lauderdale 2001), depression (Miech and Shanahan 2000), and health-fostering resources such as a sense of control (Schieman 2001).

Age-As-Lever Hypothesis

The age-as-lever hypothesis expects that educational inequality in health is increasingly larger in midlife but very small or nonexistent in early adulthood and later life (Beckett 2000; House, Lantz, and Herd 2005). Accordingly, educational disparity in health is insignificant in early adulthood since the SES differential is still limited and

biological robustness is universal among young people. In contrast, educational inequality in health is greatest in middle and early old age. During this period, SES difference in exposure to risk factors—such as risky health behaviors like smoking, lack of social relationships and support, chronic stress like financial deprivation, acute stress like job loss, lack of control—becomes more fixed and bigger. The impacts of these risk factors on physical health also start emerging. Both lead to widening inequality in health. Nevertheless, disparity shrinks again in later old age due to two reasons. First, people with high educational attainments eventually encounter biological frailty in their later life and face the accelerating rate of health decline. Second, social welfare such as Social Security and Medicare in the U.S. slows down health deterioration for the poorly-educated elderly (Herd 2006; House et al. 1990; House et al. 1994). Additionally, educational-related stressors such as economic hardship decline in the old age, which may lead to a converging gap in mental health (Mirowsky and Ross 1999). However, it is important to note that the age-as-lever theory does not emphasize the effects of education as the learned effectiveness in the discussion.

Taken together, the age dependence of health increases and the effect of education on health declines as individuals age (Lynch 2003). The empirical support for the age-as-lever hypothesis has been found for mortality (Elo and Preston 1996; Kitagawa and Hauser 1973) and functional status (Herd 2006; House et al. 1990; House et al. 1994). Whether this pattern can be found for mental health remains unclear.

Nonetheless, the apparent convergence in an educational-based difference in health in later life is usually attributed to selective survival, which means people with lower levels of education are more likely to die in earlier adulthood, leaving relatively robust persons with limited education in the elderly sample. As a consequence, an educational-gap disparity in health in old age is smaller in a biased sample full of healthy

low-educated survivors and vigorous high-educated survivors. However, with different methodological and statistical approaches, several studies have argued that selective survival was unlikely to account for appeared education convergence in physical impairment for the elderly (Beckett 2000; Beckett and Elliott 2001; Herd 2006; Noymer 2001).

The Rising Importance Hypothesis

Historical trends in increasing levels of education for generations suggest two possibilities. First, as discussed earlier, the "age as historical context" view suggests that at any given age the younger cohorts probably have lower levels of depression because they belong to cohorts experiencing favorable historical trends such as aggregate increases in education (Mirowsky and Ross 1992). Some of the age-depression associations hence reflect differences between cohorts rather than internal depression development within individuals as they age. The difference in age-specific levels of depression across cohorts has been empirically investigated most recently by Mirowsky and Kim (2007) and Yang (2007). However, inconsistent findings between these two studies raise an intriguing ambiguity. In particular, Mirowsky and Kim's findings suggest depression increases with age within each cohort and demonstrate substantial changes between cohorts in age-specific depression, as is highlighted by higher depression levels in late adulthood for younger cohorts than those for their older cohorts counterparts at the same age, while Yang's results indicates that depression decreases with age within earlier cohorts and displays higher age-specific depression levels in successively older cohorts.

The second possibility suggests the increasing importance of educational effects in explaining health improvement (Freedman and Martin 1999). Demographic studies generally found a widening educational-based gap in mortality since 1960s (Feldman et

al. 1989; Pappas et al. 1993). Some specific studies also demonstrate that the effects of education on survival for each 10-year birth cohort are greater for earlier cohorts at the same age (Lauderdale 2001) and the SES disparity in mortality for causes of death with high preventability are substantially larger than those with low preventability (Phelan et al. 2004). These findings reflect that people with high SES are more likely to take advantage of new preventive and remedial treatments for chronic diseases to improve health and prolong life (Lynch 2006; Omran 1971). Since younger cohorts live in times when health-improving knowledge and technology is more advanced, those younger cohorts with high education probably benefit more than their older cohorts counterparts at the same age. Conversely, a weakening educational-gap in health in old age may be due to the fact that these older persons belong to earlier cohorts that live in times when the rate of divergence is smaller. However, whether this hypothesis can be extended to depression remains unexamined.

3. THE ASSOCIATIONS BETWEEN EDUCATION AND HEALTH IN TAIWAN

Taiwan is an ideal setting to examine multidimensional effects of education on depression. Two subsections are incorporated into the following section. The first part summarizes the previous findings about education and health in Taiwan and discusses two perspectives: education has an overall dominant and root effect on depression; alternatively, the effects of education and the effects of other factors such as social relationships are independent of each other. The next section elucidates the reasons that the educational-based inequality in depression varies across the life course and across cohorts in Taiwan.

1) The Effects of Education: "Dominance and Protectiveness" or "Independence but Protectiveness"

A growing body of research has pointed out that education benefits several health domains of Taiwanese elders, including the initial level of morbidity, disability, functional limitation, self-reported health, and the avoidance of adverse health transition over time (Beckett et al. 2002; Tung and Mutran 2005; Zimmer, Hermalin, and Lin 2002a; Zimmer et al. 1998; Zimmer, Martin, and Chang 2002). Additionally, education is associated with lower relatively risks of dying (Liu, Hermalin, and Chuang 1998a; Zimmer, Martin, and Lin 2005) and with higher levels of "allostatic load"—an index of cumulative risk that measures chronic fluctuation on physiological system (Weinstein et al. 2003).

However, most depression studies in Taiwan center on the impacts of social relationships (Cornman et al. 2003a; Cornman et al. 2004; Weinstein et al. 2004). Several empirical studies have demonstrated that perceived support benefits psychological well-being, self-report health, and mortality (Beckett et al. 2002; Cornman et al. 2003a; Liang et al. 1999), while negative interactions such as criticism or excessive demand are associated with depression, physical impairment, and poor self-reported health (Beckett et al. 2002; Weinstein et al. 2004). However, these studies have not elaborated whether social relationships influence the education-depression patterns in Taiwan.

As a consequence, this research develops two hypotheses with taking into consideration that Taiwan is a collectivist society where extended families dominate and the values of social relationships are strongly emphasized. First, the "dominance and protectiveness" hypothesis says that education is a fundamental cause in shaping both economic and social resources, both of which improve psychological well-being. Moreover, the learned effectiveness that education instills in people empowers the effects

of education, especially when people encounter difficult times. As a result, the effects of education are dominant and protective in Taiwan.

Conversely, the "independence but protectiveness" hypothesis suggests that education shapes economic resources and provides the protectiveness of the learned effectiveness, but does not structure social relationships. Because of the entrenched family-orientated culture, Taiwanese people are not only encouraged to provide social support and show consideration for their family members but also socialized to avoid negative interactions. Due to high rates of co-residence and high prevalence of extended households, it is also common for family members to be involved with each other's life and provide any type of needed instrumental or emotional support (Zimmer, Hermalin, and Lin 2002b). In other words, maintaining supportive relationships is the inherent and prevalent behavior for Taiwanese people regardless of education levels. Therefore, the associations between education and social relationship are relatively low in Taiwan (Liu, Hermalin, and Chuang 1998b). Accordingly, educational impacts in Taiwan may not be as dominant as those in the U.S. The disadvantage that lower-educated Taiwanese encounter may be offset or replaced by other factors related to social network characteristics in the collective Taiwan society. For instance, among Taiwan's elderly, their own educational attainment actually has smaller effects than their adult child's in predicting severity of physical limitation over time (Zimmer, Hermalin, and Lin 2002a). Similarly, children's education appears more important on mortality of those older adults who already report a serious disease (Zimmer et al. 2007). Children's education seems to provide intergenerational transfers that are beneficial to the older adults' health and survival.

It is important to note that education still plays a role in stabalizing depression progression among the Taiwanese with less supportive relationships, as resource

substitution theory suggested, even though education and social relationships influence depression independently in Taiwan. In other words, the Taiwanese with less education but strong social supportive relationships probably still maintain stable mental health; however, those with less education and less resources in supportive relationships are more likely to face serious depression over the life course.

2) The Life Course and Cohort Perspectives

Life Course Perspectives: Reversed Aging Trajectories Hypothesis

This research proposes the "reversed aging trajectories" hypothesis, predicting aging trajectory in depression differs across levels of education in Taiwan. The trajectories benefit the less educated in early adulthood but the patterns are reversed past middle life, which reinforces educational-based divergence in depression. On the foundation of the "age as life stage" perspective, the pace of the life course depends on education. The well-educated Taiwanese are generally in school—a crucial stressor itself due to strict academic performance requirements and competitive environment resulted from tracking system—or just graduated and in their early adulthood, which delay the development of resources in marital, economic, and work aspects. The well educated are hence more depressed in their early life. Fortunately, the effects of education start emerging during their middle life because education enables them to acquire highly ranked occupations or elevated social prestige (Hsieh et al. 1999; Tsurumi 1977). They are also able to raise their children and support their family members like parents under more stable economic environments. The average levels of depression are relatively lower in the middle life. Meanwhile, as discussed earlier, if education is the learned effectiveness that empowers individuals to maintain psychological well-being during

difficult times, the extent of the rise in depression in late life due to physical decline, retirement and widowhood will be relatively smaller for the well-educated Taiwanese.

Conversely, the less-educated Taiwanese tend to have a full-time job and be married in their early adulthood, both of which benefit psychological well-being. Nonetheless, the income and wealth growth is relatively lower among the less educated, but the difficulty meeting living expenses is surging due to the rising costs for their children's education and their aging parents' medical services. Depression thus steeply increases during the middle life. The lack of learned effectiveness from education jeopardizes the deterioration in depression resulted from their disadvantage status in economic aspects, producing a growing gap across levels of education in the middle and late life.

Taken as a whole, the "reverse aging trajectories" hypothesis suggests that education differentiates aging trajectories in depression and the educational-based disparity in depression starts widening in the middle adulthood in Taiwan.

Cohort Perspectives

With taking into account the rapid social change and specific historical experiences, as extensively discussed in earlier sections, it is highly plausible that educational impacts on health vary across cohorts in Taiwan. Older Taiwanese cohorts may live in times with huge social change, political turmoil, material deprivation, and prevalent unpreventable causes of death. According to the epidemiologic transition theory and the fundamental cause theory introduced earlier (Omran 1971; Phelan et al. 2004), the rate of educational divergence in health tends to be smaller in the society with above characteristics. Likewise, younger Taiwanese cohorts live in an age of stable social environment, affluent economy, accessible medical technology, advanced health

knowledge, and highly preventable major causes of death. The rate of educational divergence in health hence grows more quickly. As a consequence, this research hypothesizes the effects of education on depression are greater for younger generations.

Chapter 3: Data, Measures, and Methods

1. DATA

1) Taiwan Social Change Survey

Taiwan Social Change Survey (TSCS) consists of a series of repeated cross-sectional national representative samples and is conducted annually in the mode of face-to-face interviews by the Institute of Sociology and the Center for Survey Research, Academia Sinica. The same multi-staged stratified random sampling scheme and "probability proportional to their size (PPS)" method are utilized for all TSCS. The total 359 townships or districts of Taiwan are divided into 10 strata according to the degree of urbanization and geographic locations. Administrative neighborhoods and individuals in each stratum are then in turn randomly selected.

Since the first national-wide survey launched in 1985, TSCS has adopted 5-year cycles that rotate selective topics in order to track long-term trends of social change in Taiwan. The 1990, 1995, 2000, and 2005 samples—the original samples of 2,531 respondents ranging in age from 20 to 64, 2,081 respondents ranging in age from 20 to 75, 1,895 respondents ranging in age from 21 to 91, and 2,146 respondents ranging in age from 19 to 97, respectively—provide mental health-related questions and are hence used in this study. In general, cases with missing values are excluded by listwise deletion approach in the following TSCS analyses.

TSCS data are mainly utilized to elucidate three questions in this study (details are further discussed in the methods section). First, the cross-sectional age-related change in depression within each sample is delineated separately. The similar results across samples suggest a reliable description about the age-depression pattern in Taiwan.

Furthermore, this study pools these four samples together to observe individuals from different cohorts but at the same phases in the life course and then clarify whether the age-depression pattern differs across cohorts. The similar approach had been empirically adopted in the U.S. study (Lynch 2003). The oversample problems resulted from different age structures and sample sizes across samples do not cause biased results because of the inclusion of variables on which sampling is based, such as age, in all analysis. It is hence unnecessary to use sample weights in the analyses to obtain unbiased coefficients (Winship and Radbill 1994). Last but not least, the 2005 sample is examined to elaborate whether the age-depression patterns are explained by social factors such as education, economic resources, or social relationships, etc.

2) The Survey of Health and Living Status of the Middle Aged and Elderly in Taiwan, 1989-2003

The Survey of Health and Living Status of the Middle Aged and Elderly in Taiwan is a longitudinal dataset which consists of national representative samples of the elderly population residing in non-aboriginal areas of Taiwan, including those in institutions such as nursing homes or long-term hospitals. The surveys are designed jointly by the Bureau of Health Promotion of the Department of Health, Taiwan, and by several institutions at the University of Michigan, Georgetown University, and Princeton University. The surveys are conducted in the mode of face-to-face interviews and are derived from the multi-stage equal probability sampling. The primary sampling unit is townships, while blocks in the selected townships serve as clusters in the second stage. Each stage is selected proportional to size. Finally, two elderly persons were selected randomly from each selected block.

Two panel samples are incorporated into this dataset. The first sample includes 4,049 respondents ranging in age from 60 to 96 in 1989 with the response rate of 91.8%. Follow-up interviews were undertaken in 1993, 1996, 1999, and 2003 with the sample sizes of 3,155, 2,669, 2,310, and 1,743, respectively. The number of respondents participated in all waves is 1,480. The numbers of attrition due to death increased from 582 in 1993, 1,047 in 1996, 1,486 in 1999, to 2,133 in 2003. Meanwhile, 424 respondents were dropped out due to reasons other than death.

The second panel sample contains 2,462 respondents ranging in age from 50 to 70 in 1996 with the response rate of 81.2%. Follow-up interviews were taken in 1999 and 2003 with the sample sizes of 2,130 and 2,035, respectively. The number of respondents participated in all waves is 1,892. However, 253 respondents dropped out due to death by the last wave in 2003, while 318 were lost to follow-up due to other reasons. The differences of characteristics between individuals who consistently participate and individuals who dropped out due to death or other reasons are further discussed in the measures section.

It is essential to note that this study uses different approaches to deal with missing values in the cross-sectional analyses and the aging vector models (details are introduced in the method section) based on panel data The cross-sectional analyses based on the baseline elderly sample and the baseline middle-aged sample straightforwardly exclude respondents for whom information on depression or other key variables of interest were missing; while the aging vector models correct missing values based on all available data from both elderly and middle-aged panel samples via Full-Information Maximum Likelihood (FIML) procedure implemented in the AMOS Structure Equation Modeling program (version 16.0).

FIML is an estimating approach that uses all available data regardless of their status in the follow-up interviews (Wothke 2000) and compensate for missing data due to nonresponse or attrition based on the assumption of "missing at ransom" (MAR), meaning that the structural relationships vary only randomly across groups and suggesting the absence of values depend upon a combination of random change and tendencies predictable form all observed data (Mirowsky and Ross 2007; Singer and Willett 2003). In other words, the absence of values does not depend on the unobserved values themselves. The assumption is likely violated for decedents dropping out of surveys: unobserved depression for a decedent would be quite high if they were actually observed. However, the violation of this assumption mainly leads to underestimation of the steepness of the health trajectory for decedents, which causes underestimation of between-group inequalities in the slopes of trajectories (Lynch 2003). Moreover, adding variables such as baseline values and nonmissing follow-up values strengthens the correction for attrition and the unobserved values (Collins, Schafer, and Kam 2001). The aging-vector models used in this study include age, sex, education, physical health, economic resources, and social relationships, all of which are associated with depression and with the likelihood of attrition. A strong association between observed and missing values hence makes the correction robust. In essence, aging-vector models estimated with FIML procedures considerably lessen attrition bias, provide more accurate estimation than traditional approaches such as listwise deletion, pairwise deletion, and mean-imputation, and are more robust than methods based on adjustment for the hazard of attrition (Mirowsky and Kim 2007; Mirowsky and Reynolds 2000).

2. MEASURES

1) Taiwan Social Change Survey

Health Measures

Depression is gauged by a 4-item index based on the question, "In the last two weeks, have you" (1) "slept poorly," (2) "felt that many things are an effort," (3) "felt a loss of self-confidence," and (4) "felt that life is hopeless." Responses include "never", "normal", "more than usual", and "much more than usual" (coded as 0 to 3). The index of depression is the mean response to applicable items. Eight respondents who answered two or less items are dropped. These four surveys report the Alpha reliability as .69, .67, .69, .71, respectively. In addition, past research has indicated that the cultural bias does not significantly influence the reliability of depression scale in Taiwan (Son, Lin, and George 2008).

Physical Impairment is measured according to a single question, "Has your daily life (such as study, work, or housework) been influenced by physical discomfort or injury in the last two weeks?" Responses include "no physical discomfort or injury", "slightly", " fairly", and "substantially" (coded 0 to 3).

Demographic Measures

Age is the year of survey minus the year of birth, while *Cohort* is measured as the year of birth. *Female* is a dummy variable comparing females (1) with males (0). *Mainlander* is coded as 1 if individuals have indicated their father is a Mainlander and as 0 otherwise. This division of ethnicity reflects the distinct historical and socio-structural background in Taiwan and is commonly used in most health studies (Beckett et al. 2002; Tung and Mutran 2005; Zimmer, Hermalin, and Lin 2002a; Zimmer et al. 1998).

SES Measures

Among SES measures, *Education* is scored in years of education according to the highest level of education reported. Education years are computed for respondents who dropped out during their highest education pursuit but reported the actual years they stayed in the programs. Meanwhile, four dummy variables are constructed to distinguish *Education Levels*—elementary school or less, junior and senior high school, some college, and college degree or above—and are used in the selected models.

Economic Hardship is measured by asking respondents, "Do you feel your (and your spouse's) current income is enough for your living expenses?" Responses ranged from "very sufficient", "sufficient", "just enough", "insufficient", and "very insufficient" (coded as 1 to 5). *Income* is accessed based on the reported monthly household income and is categorized into three dummy variables representing respondents in the highest third, the middle third, and the lowest third, which is served as a reference group. A dummy variable of missing income is also established to represent 154 respondents who did not report household income. *Employment Status* includes a series of dichotomous variables represent employed, unemployed, retired, housewife, and student.

Economic Satisfaction is measured according to the response to the question, "Are you satisfied with your current economic condition"; while *Work Satisfaction* is assessed by asking respondents, "Overall, are you satisfied with your major work?" Responses to both questions are ranged from "very dissatisfied", "dissatisfied", "satisfied", and "very satisfied" (coded as 1 to 4).

Social Relationships Measures

Marital Status is assessed by four dichotomous variables: married, single, divorced/separated, and widowed. *Social Support* is displayed as the score based on the question, "When you have trouble and worry, can you get satisfied assistance from your family?" Responses are ranged from "almost never", "sometimes", and "always" (coded as 1 to 3). Meanwhile, *Negative Interaction* is a continuous variable denoting the number of the following types of behaviors happening within the family in the last year: "do not talk with each other", "quarrel or confrontation", "throw or smash stuffs", and "fight or brawl".

Alienation Measures

Four types of alienation, *Powerlessness*, *Mistrust*, *Normlessness*, and *Meaningless* are based on the response to the questions: "unless good luck, it is very difficult for a person to succeed", "there are no reliable and trustworthy interpersonal relationships", "what other people think is always changing, so I don't know what is expected", and "there is no meaning to life", respectively. Responses for all of these questions are "strongly disagree", "disagree", "slightly disagree", "no opinion", "slightly agree", "agree", and "strongly agree" (coded as -3 to 3).

2) The Survey of Health and Living Status of the Middle Aged and Elderly in Taiwan, 1989-2003

Health Measures

Depression is constructed based on eight questions drawn from the Center for Epidemiological Studies-Depression Scale (CES-D). These questions are used to evaluate

two dimensions of depression: depressed mood and malaise. Depression mood questions include, “In the past year, have you experienced the following situations or feelings?” (1) “felt you were in a terrible mood,” (2) “felt lonely,” (3) “felt people around you were not nice to you,” and (4) “felt sad.”; while malaise questions are “In the past year, have you experienced the following situations or feelings?” (1) “Not interested in eating, had a poor appetite,” (2) “felt that doing anything was exhausting,” (3) “sleep poorly,” and (4) “unable to gather your energy to do things.” Responses are “rarely”, “sometimes”, “often”, and “very often” (coded as 0 to 3).

For the baseline cross-sectional analyses for each middle-aged sample and elderly sample, *Depression* averages the scores of eight items from the above mood and malaise indexes drawn from the baseline wave. Meanwhile, 9 middle aged and 19 elderly respondents failed to answer all 8 items but responded to at least 6 items. Their depression score is the mean of the valid items. The alpha reliability for each baseline sample is .83 and .82, respectively.

For the longitudinal aging vectors analyses, both *Depression Mood* and *Malaise* indicators are used. *Depressed Mood* averages the scores of four related items. The alpha reliability of the index in five waves are .71, .80, .78, .82, and.76, respectively. *Malaise* averages the scores of its four related items. The alpha reliability of the index in five waves are .69, .73, 78, .78, and .73, respectively. Coding decisions for 60 and 35 individuals who did not respond to one of the four items are the mean score of the remaining valid items. Respondents with more than two missing responses were omitted.

Physical Impairment is measured according to responses to six questions regarding the ability to perform general physical movements that might be necessary for conducting daily activities: bathing, walking 200 to 300 meters, crouching, climbing stairs, reaching up over head, and using fingers to grasp or handle items. Respondents

were asked whether they had any difficulty performing these tasks without assistance. Responses are "no problem", "some difficulty", "very difficult", and "unable to do them at all" (coded as 0 to 3). The alpha reliability of the index in the five waves are .89, .90, .89, .89, .89, The concurrent validity with self-reported functional health has been well evaluated in diverse elderly populations (Beckett et al. 2002). The physical impairment index is the mean response. Coding decisions for 141 individuals who did not respond to one out of the six items and for 13 other individuals who did not respond to two of the items are the mean scores of the remaining valid items. Otherwise were omitted.

Seven of the eight leading causes of death in Taiwan—stroke, heart disease, diabetes, lung disease, liver disease, kidney disease, and hypertension—are each constructed as a dichotomous measure comparing respondents answer having the disease (1) and the one without the disease (0). *The Number of Life-Risky Diseases* is denoted as a continuous measure (ranging from 0 to 7 of the diseases described above). Unfortunately, questions about cancer, the first leading cause of death, were not included in the 1989 baseline wave.

Demographic Measures

Among demographic variables, *Age* is measured in number of years in 1996 and centered as a deviation from age 70. *Female* is a dummy variable comparing females (1) with males (0). *Mainlander* is a dummy variable comparing Mainlanders (1) and other ethnic groups (0).

SES Measures

Education is scored as highest years of schooling. Respondents who attended graduate schools are counted as 19. Respondents who did not receive formal education but report "literate" are counted as 3.

The information about the highest educational level of all living children of each respondent is collected. The dummy variable is constructed to compare respondents having child with more than 13 years of education (1) and otherwise (0).

Economic Hardship is created according to responses to a question, "Do you (and your spouse) have enough money or any difficulty meeting monthly living expenses or other expenditures?" Responses are ranged from "enough money and with some left over," "just enough money and with no difficulty," "with some difficulty," and "with much difficulty" (coded as 1 to 4). In addition, three dummy variables are made to distinguish four temporal categories of economic hardship: stable high hardship, stable low hardship, rising hardship, and falling hardship. *Higher Hardship* represents respondents who answered "with some difficulty" or "with much difficulty" at the baseline. *Rising Hardship* represents respondents who answered "enough money and with some left over" or "just enough money and with no difficulty" at the baseline but moved to "with some difficulty" or "with much difficulty" at their last valid wave. Conversely, *Falling Hardship* refers to respondents who answered the last two categories at the baseline but moved to the first two categories at their last valid wave. The combination of these three variables provides information to specify *Stable High Hardship* for respondents who belong at the high hardship group at the baseline and the last valid wave, and *Stable Low Hardship* for respondents did not belong to the high hardship group at the baseline wave and their last wave.

Income is represented as the ordinal index distinguishing individuals in the highest third, the middle third, and the lowest third income distribution in each wave. A dummy variable identifying individuals who had not reported income information is also established. The above coding strategy is most practical since the response intervals of the income question in each wave are not consistent. Meanwhile, the questions about income are not identical across waves: as the couple income in the 1989, 1996, 1999, and 2003 sample, while as personal income in 1993.

Employment Status includes three dichotomous variables: *Currently Having Jobs* (1) and otherwise (0); *Currently Out of the Labor Force* (1) and otherwise (0); and *Have Never Worked* (1) and otherwise (0).

Occupational Prestige is the score of the major occupation that respondents have had. These scores are based on the Taiwanese Socioeconomic Index derived from the prestige, education and income related to 82 occupational titles (Tsai and Chiu 1991). Meanwhile, *Low Occupation*, the dummy variable, is coded as 1 as being the lowest third in the prestige score distribution and as 0 otherwise.

Non-investor is coded as 1 as the dummy variable representing individuals who did not report owning any property (such as another house other than the one they live, assets, savings, stocks, etc) and as 0 otherwise. Individuals who have transferred their properties to their children are still regarded as investors. However, questions about intergeneration transfer are not collected in the 1999 and 2003 waves.

Social Relationships Measures

Widowed is a dummy variable that contrasts widowed persons (1) with non-widowed (0). Being widowed is a better variable than being married in the Taiwanese context since few Taiwanese elderly remain single or become divorced. *New-widowed* is

a dummy variable that equals 1 if respondents report they lost a spouse since the baseline wave, and 0 otherwise.

Co-residence is the dummy variable for those who live with, or contact, their children daily (1) and otherwise (0); while *Without Living Child* is coded as 1 for respondents without any living child and as 0 otherwise.

Social Support is measured by responses to three questions: "How much do you feel that your family, relatives, or friends are willing to listen when you need to talk about your worries or problems?" "How much do your family, relatives, or friends make you feel loved and cared for?"; and "In general, how much can you count on your family or relatives to take care of you when you are ill?" (coded 1: very little or not at all, 2: some, and 3: a great deal or quite a bit). The social support index is the mean score of the valid items. In order to classify the temporal social support, a series of dummy variables for each social support dimension are generated in order to distinguish *Rising Social Support*, *Falling Social Support*, and *Stable Social Support*. Rising social support is a dummy variable that equals 1 if the respondent moves from "below or equals 2" in the first valid wave to "over 2" in the last valid wave. Falling social support is a dummy variable that equals 1 if respondents moved from "over 2 " to "below or equals 2," respectively. Otherwise, respondents are regarded as having stable support. Nonetheless, if needed, stable social support can be further categorized into two dummy variables: *Stable High Support* (1) and otherwise (0); and *Stable Low Support* (1) and otherwise (0).

Relationships Dissatisfaction is a dummy variable measured by asking: "In general, how satisfied are you with the type of emotional support you receive from your family or relatives?" Respondents who did not report being satisfied or very satisfied are coded as 1, and otherwise are coded as 0. A series of dummy variables for each dissatisfaction dimension are generated in order to distinguish *Rising Dissatisfaction*,

Falling Dissatisfaction, and *Stable Dissatisfaction*. Rising dissatisfaction is a dummy variable that equals 1 if dissatisfaction is 0 in the first valid wave and 1 in the final valid wave. Falling dissatisfaction is a dummy variable that equals 1 if dissatisfaction is 1 in the first wave and 0 in the last valid wave. Otherwise, respondents are regarded as having stable dissatisfaction. However, if needed, stable dissatisfaction can be separated into: *Stable High Dissatisfaction* (1) and otherwise (0); and *Stable Low Dissatisfaction* (1) and otherwise (0).

Familial Criticism Exposure is measured by asking respondents: "How often do you feel that your family, relatives, or friends are critical of what you do?" (coded 1: never, 2: sometimes, and 3: very often). Four dummy variables for each critical dimension are generated in order to distinguish *Rising Criticism*, *Falling Criticism*, and *Stable Criticism*. Rising criticism is a dummy variable that equals 1 if respondents moved from "below than 2" in the first valid wave to "above or equals 2" in the last valid wave. Falling criticism is a dummy variable that equals 1 if respondents moved from "above or equals 2" to "below 2," respectively. Otherwise, respondents are regarded as having stable criticism. If needed, stable criticism can be further grouped into two dummy variables: Stable High Support (1) and otherwise (0); and Stable Low Criticism (1) and otherwise (0).

3) Descriptive Statistics

Depression Across the Life Course

Table 3.1 and Table 3.2 demonstrate the means of depression across 5-year age groups and across 5-year cohorts, based on the pooled 1990, 1995, 2000, and 2005 TSCS data and on all surveys from the 1989, 1993, 1996, 1999, and 2003 Survey of Health and

Living Status of the Middle Aged and Elderly in Taiwan. The analyses regard the elderly panel samples as if it were a cross-sectional, utilizing a person-year structure for the data, and ignoring within-individual error correlation. To begin with, the average levels of depression generally follow a U-shaped trajectory, declining in early adulthood (roughly before age 40), bottoming out in middle age (roughly from age 40 to 60), and then rising again in old age (roughly after age 60). Nonetheless, two exceptions are found. First, the average levels of depression drop slightly around age 65 in the pooled TSCS data. The decline in depression is probably the tentative fluctuation related to the transition into retirement. Second, the average levels of depression diminish among the oldest old, such as individuals over age 85 in the TSCS data and those over age 90 in the elderly panel samples. Mortality selection may explain this obvious decline in depression. These oldest old are survivors are characterized by with lower levels of depression. In addition, because average levels of depression still increase within these oldest-old in the TSCS samples and the average level of depression of individuals over aged 90 is higher than the average of the 80-84 age group in the elderly samples, it is still more likely that depression increases in late adulthood.

Furthermore, disjunctive cohort variations in the trends of depression are displayed. On the one hand, among individuals who were born before 1940, more recent cohorts are generally associated with higher levels of age-specific depression than their older cohorts counterparts. Likewise, among individuals who were born after 1946, more recent cohorts generally report higher levels of age-specific depression than their older cohorts counterparts. Nevertheless, individuals who were born between 1941 and 1945 seem to have overall lower levels of depression than their younger and older cohorts counterparts at the same age.

Table 3.1: Means of Depression (4-items CES-D Scores) by Age and Cohort: Taiwan, The Pooled TSCS Data (1990, 1995, 2000, and 2005).

	Birth Cohort															
Age Group	1908 ~15	1916 ~20	1921 ~25	1926 ~30	1931 ~35	1936 ~40	1941 ~45	1946 ~50	1951 ~55	1956 ~60	1961 ~65	1966 ~70	1971 ~75	1976 ~80	1981 ~86	Total
<= 24 (n=848)												.545	.622	.609	.615	.592
25-29 (n=968)											.451	.513	.538	.670		.529
30-34 (n=1,161)										.447	.490	.608	.718			.528
35-39 (n=1,286)									.437	.481	.536	.588				.496
40-44 (n=1,018)								.389	.403	.548	.524					.461
45-49 (n=856)							.414	.493	.491	.558						.491
50-54 (n=673)						.503	.439	.452	.564							.502
55-59 (n=504)					.509	.541	.453	.607								.529
60-64 (n=491)				.423	.456	.562	.589									.504
65-69 (n=337)				.454	.528	.600										.518
70-74 (n=292)			.506	.574	.644											.571
75-79 (n=121)		.475	.645	.724												.676
80-84 (n=55)		.542	.520													.527
85-89 (n=21)	.469	.365														.405
90 <= (n=8)	.469															.469
N of Cases	16	41	186	440	459	483	584	731	1205	1319	1131	920	478	360	290	8,643

Note: n refers to the number of respondents within each age interval; Number of cases refers to the number of respondents within each cohort group.

Table 3.2: Means of Depression (8-items CES-D Scores) by Age and Cohort: Taiwan, the 1989, 1993, 1996, 1999, and 2003 Survey of Health and Living Status of the Middle Aged and Elderly in Taiwan.

	Birth Cohort									
Age Group	1893 ~1905	1906 ~1910	1911 ~1915	1916 ~1920	1921 ~1925	1926 ~1930	1931 ~1935	1936 ~1940	1941 ~1946	Total
<= 54 (n=878)									.289	.289
55-59 (n=1,769)								.372	.317	.340
60-64 (n=3,565)					.393	.379	.472	.368	.336	.389
65-69 (n=4,361)				.357	.394	.452	.403	.391		.417
70-74 (n=4,052)			.478	.460	.526	.482	.413			.488
75-79 (n=2,817)		.473	.478	.558	.513	.450				.505
80-84 (n=1,288)	.513	.519	.596	.631	.429					.557
85-89 (n=390)	.577	.736	.740	.567						.677
90 <= (n=108)	.507	.693	.613							.585
Number of Cases	134	380	1,175	2,252	4,342	4,973	1,707	1,995	2,270	19,228

Note: The pooled data include all waves in 1989, 1993, 1996, 1999, and 2003. At each follow-up wave, those who survived had aged by years from the age in 1989.
n refers to the number of respondents within each age interval; Number of cases refer to the number of respondents within each cohort group.

It is plausible that the disjunction of depression trends reflect the "breaking period" of differences of historical experiences across cohorts in Taiwan. The older cohorts born before 1940 are the ones that encountered material deprivation during wartimes and political turmoil during the post-war transition period in Taiwan. Hence, they have higher levels of depression and higher risks of physical diseases than the 1941-1945 birth cohort, the first cohort who grew up in the post-World War Two period. On the other hand, Taiwanese born after 1945 live in an age of contemporary industrialized societies. Younger cohorts may be more depressed than their older cohorts at the same age because they operate in more competitive environments and are involved in busier life styles. Depression thus strengthens in successively more recent cohorts among those post-war generations. More recent cohorts are thus more depressed than the 1941-1945 birth cohort. Taken together, the 1941-1945 is the cohort group with lowest average level of depression.

Characteristics by Education Levels

Table 3.3 to Table 3.5 indicate overall characteristic differences by education levels, based on the 2005 TSCS sample and the elderly and middle-aged baseline samples. Although the mean years of education differ across samples with diverse age structures, individuals with more education are generally less depressed and have lower levels of physical impairment and lower risks of chronic diseases than their counterparts within the same sample, regardless of ethnicity and sex. The only exception is that individuals with college levels or higher education are slightly more depressed (but statistically insignificant) than their counterparts with some college years in the 2005 TSCS data. The plausible reason is that people with college degrees or more tend to

Table 3.3: Means (with Standard Deviation) or Percentages of Variables in the Analyses by Education Levels: Taiwan, 2005 TSCS.

	Education Levels (Mean = 10.674)				
Variables	<= 6	7-12	13-15	16 <=	Total
Baseline Health					
Depression	.693***	.618**	.519	.527	.605
	(.643)	(.577)	(.507)	(.478)	(.571)
Physical Impairment	.534***	.329*	.275	.253	.359
	(.822)	(.676)	(.561)	(.508)	(.681)
Demographic Characteristics					
Age	62.660***	41.387***	36.168*	33.957	44.626
	(11.429)	(13.553)	(11.983)	(13.711)	(16.924)
Cohort [Range]	1942.340***	1963.613***	1968.832*	1971.043	1960.374
	[1908, 1976]	[1916, 1986]	[1927, 1986]	[1916, 1986]	[1908, 1986]
Female (%)	.623***	.474**	.507**	.392	.500
Mainlander (%)	.036***	.096***	.141	.178	.104
Socioeconomic Characteristics					
Economic Hardship	3.482***	3.089***	2.604	2.563	3.015
	(1.023)	(1.059)	(.894)	(.986)	(1.072)
Income Level (%)					
Highest Third	.094***	.211***	.416**	.503	.269
Middle Third	.141***	.318	.383**	.296	.277
Lowest Third	.655***	.413***	.141	.144	.383
Missing Information	.110**	.059	.060	.057	.072
Employment (%)					
Employed	.451***	.717**	.772***	.647	.641
Unemployed	.061	.062	.047	.048	.057
Student	.000***	.020***	.071***	.237	.066
Housewife	.267***	.139***	.067***	.011	.136
Retried	.220***	.061	.044	.055	.098
Economic Dissatisfaction	1.562***	1.505***	1.329	1.312	1.456
	(.756)	(.686)	(.635)	(.590)	(.687)
Work Dissatisfaction	1.287**	1.307***	1.201	1.175	1.260
	(.658)	(.606)	(.608)	(.556)	(.613)
Social Relationships Characteristics					
Marital Status (%)					
Married	.758***	.712***	.591***	.417	.647
Single	.024***	.220***	.386***	.563	.262
Divorced	.024^{+}	.046***	.017	.011	.029
Widowed	.193***	.022*	.007	.009	.062
Social Support	2.106*	2.083**	2.181	2.213	2.129
	(.823)	(.769)	(.662)	(.671)	(.752)
Negative Interaction	.480***	.738*	.862	.818	.705
	(.749)	(.777)	(.768)	(.773)	(.780)
Alienation					
Powerlessness	.493***	-.174***	-.436^{+}	-.643	-.134
	(1.785)	(1.899)	(1.871)	(1.759)	(1.882)
Mistrust	.114***	-.533***	-.869**	-1.186	-.546
	(1.804)	(1.756)	(1.576)	(1.512)	(1.757)

Normlessness	.672***	.864***	.736***	.077	.636
	(1.490)	(1.644)	(1.736)	(1.796)	(1.676)
Meaningless	-1.065***	-1.535***	-1.752**	-1.977	-1.534
	(1.682)	(1.399)	(1.228)	(1.066)	(1.433)
Number of Respondents	554	855	298	439	2146

Note: $^{+}$ p < .10; * p < .05; ** p < .01; *** p < .001 (one-tailed t-tests for difference between means and one-tailed proportion test for difference between percentages by education levels; compared to respondents with 16 and above education years).

Table 3.4: Means of Mental Health and Physical Health by Ethnicity, Sex, and Education Levels: Taiwan, the Combined Elderly and Middle-Aged Baseline Sample (Total N=6,511).

	Non-Mainlanders						Mainlanders					
	Male			Female			Male			Female		
Education	< 6	= 6	6 <	< 6	= 6	6 <	< 6	= 6	6 <	< 6	= 6	6 <
Depression	.374*	.299*	.226	.531*	.357	.345	.397*	.450*	.288	.650*	.524^{+}	.313
	(.516)	(.476)	(.412)	(.605)	(.503)	(.550)	(.542)	(.622)	(.455)	(.672)	(.586)	(.432)
Physical	.181*	.121*	.058	.300*	.109^{+}	.077	.183*	.151	.111	.332*	.206*	.113
Impairment	(.402)	(.356)	(.305)	(.531)	(.296)	(.273)	(.434)	(.374)	(.330)	(.508)	(.293)	(.205)
N	883	1062	605	1863	576	195	274	153	455	80	21	74

$^{+}$ p < .05; * p < .01 (one-tailed t-tests for difference between means of depression scores within each ethnicity-sex category by education levels; compared to respondents with more than 6 education years).

engage in professional occupation characteristics of high stress, such as being engineers in the technology industry. Hence, they report higher levels of depression, even though they are actually physically healthier.

Demographic, economic, and social characteristics all differ across education levels. Demographically speaking, individuals with more education tend to be younger and belong to more recent cohorts, reflecting the transformation of the educational environments in Taiwan over the last century. Meanwhile, females are underrepresented and Mainlanders are overrepresented. Economically speaking, the well educated tend to have health-enhancing resources in economic, employment, work, and occupational resources. First, the well-educated Taiwanese not only have lower levels of economic hardship and higher levels of income, but also keep persistent lower economic hardship over time than their counterparts within the same sample. They are also less likely to face or be dissatisfied with their economic situation. Subsequently, the well educated tend to

Table 3.5: Means (with Standard Deviation) or Percentages of Baseline Variables and Selected Temporal Characteristics in the Analyses by Education Levels: Taiwan, the Elderly Sample and the Middle-Aged Sample (Total Baseline Number = 6,511).

	The 1989 Elderly Sample By Education Levels (Mean = 4.148)			The 1996 Middle Aged Sample By Education Levels (Mean = 5.436)		
Variables	< 6	= 6	6 <	< 6	= 6	6 <
BASELINE CHARACTERISTICS						
Baseline Health						
Depression	.468***	.343***	.267	.499***	.322*	.272
	(.575)	(.503)	(.425)	(.599)	(.501)	(.485)
Physical Impairment	.304***	.154**	.107	.143***	.085*	.050
	(.535)	(.366)	(.336)	(.343)	(.303)	(.258)
# of Life-Risky Diseases	.943**	.856	.823	.727**	.618	.578
	(1.048)	(1.023)	(1.003)	(.994)	(.969)	(.800)
Demographic Characteristics						
Age at the Baseline Wave	69.201***	66.110	66.263	58.838***	57.406	57.335
	(6.580)	(5.358)	(5.347)	(4.301)	(4.965)	(5.256)
Cohort [Range]	1919.799***	1922.890	1922.737	1937.162***	1938.594	1938.665
	[1893, 1929]	[1899,1929]	[1898, 1929]	[1926, 1946]	[1927, 1946]	[1926, 1946]
Female (%)	.594***	.264***	.153	.707***	.400***	.267
Mainlander (%)	.039***	.038***	.187	.145***	.150***	.558
Socioeconomic Characteristics						
Having Child with 13+ Education Years (%)	.217***	.420***	.692	.330***	.527***	.759
Economic Hardship	1.278***	1.072***	.863	1.327***	1.230***	.982
	(.716)	(.658)	(.649)	(.605)	(.565)	(.581)
Income Level (%)						
Highest Third	.162***	.334***	.636	.044***	.116***	.431
Middle Third	.376***	.397***	.284	.192***	.264	.279
Lowest Third	.445***	.257***	.070	.523***	.391***	.164
Missing Information	.017+	.013***	.009	.241***	.229	.126
Employment (%)						
Having Jobs	.225***	.356+	.389	.375***	.520***	.635
Out of Labor Force	.570	.540	.566	.378***	.346*	.291
Have Never Worked	.204***	.104***	.042	.247***	.134***	.073
Occupation Prestige (%)						
Highest Third	.108***	.286***	.642	.112***	.255***	.693
Middle Third	.293***	.263***	.060	.380***	.381***	.131
Lowest Third	.316***	.217**	.161	.502***	.350***	.166
Missing Information	.283***	.233***	.138	.007	.014	.011
Non-Investor (%)	.215***	.136	.132	.148***	.120*	.082
Social Relationships Characteristics						
Widowed at Baseline (%)	.367***	.186**	.136	.160***	.101***	.051
Without living child (%)	.021	.022	.019	.027*	.022**	.044
Live with or Contact Child Daily (%)	.792***	.775**	.714	.843*	.855**	.798
Social Support	2.189***	2.336	2.349	2.667**	2.724	2.732
	(.469)	(.446)	(.434)	(.486)	(.463)	(.462)

Relationships Dissatisfy (%)	.301***	.251*	.214	.246***	.179	.156
Familial Criticism Exposure	1.322*	1.308**	1.359	1.357	1.360	1.336
	(.426)	(.417)	(.457)	(.517)	(.515)	(.515)
TEMPORAL CHARACTERISTICS ACROSS WAVES						
Economic Hardship (%)						
Stable High Hardship	.109***	.073***	.027	.177***	.114***	.045
Stable Low Hardship	.416***	.588**	.657	.415***	.509***	.670
Rising Hardship	.148***	.110*	.083	.219**	.183	.164
Falling Hardship	.111***	.075	.062	.113***	.096***	.045
One Wave Only or Missing Data	.216**	.154	.171	.075	.099^{+}	.075
New Widowed (%)	.178***	.175***	.105	.103***	.052**	.026
Social Support (%)						
Stable High Support	.411***	.551*	.602	.692**	.730+	.763
Stable Low Support	.097**	.055	.053	.037	.032	.035
Rising Support	.198***	.159**	.116	.092*	.074	.066
Falling Support	.077*	.083*	.056	.106**	.070	.061
One Wave Only or Missing Data	.218	.152**	.173	.073	.094	.075
Relationships Dissatisfy (%)						
Stable High Dissatisfy	.070^{+}	.061	.054	.079*	.047	.049
Stable Low Dissatisfy	.420***	.525	.540	.590***	.632*	.688
Rising Dissatisfy	.139*	.115	.110	.116	.109	.101
Falling Dissatisfy	.153*	.147^{+}	.122	.142***	.114^{+}	.087
One Wave Only or Missing Data	.218**	.153	.175	.073	.098^{+}	.075
Familial Criticism (%)						
Stable High Criticism	.054	.045	.046	.119	.119	.110
Stable Low Criticism	.438**	.545*	.497	.432	.435	.450
Rising Criticism	.186**	.150	.142	.188	.163	.185
Falling Criticism	.104**	.107*	.140	.187	.189	.178
One Wave Only or Missing Data	.218**	.154	.175	.074	.094	.077
Number of Respondents	2,197	943	756	903	869	573

Note: The sample sizes of physical impairment, economic hardship, support, relationships dissatisfaction, critic within the family are 7, 48, 7, 15, 10 less than the total sample size listed—6,511—respectively.
$^{+}$ p < .10; * p < .05; ** p < .01; *** p < .001 (one-tailed t-tests for difference between means and one-tailed proportion test for difference between percentages by education levels; compared to respondents with more than 6 education years).

be currently employed and have never worked over their whole lives. The well-educated females are less likely to be housewives. Third, the well educated are less likely to be dissatisfied with their work environments. Fourth, the well educated have higher occupation prestige. Moreover, the well-educated Taiwanese elderly tend to have highly educated children and own more properties (such as houses other than the one they live,

Table 3.6: Means (with Standard Deviation) or Percentages of Baseline Variables in the Analyses by Survival/Attrition Status: Taiwan, the 1989 Elderly Sample and the 1996 Middle-Aged Sample (Total N = 6,511).

	The 1989 Elderly Sample				The 1996 Middle-Aged Sample			
	Survival/Attrition Status				Survival/Attrition Status			
Variables	Survivals Without Attrition	Survivals With Attrition	Died Prior to the Last Wave	Total Baseline Sample	Survivals Without Attrition	Survivals With Attrition	Died Prior to the Last Wave	Total Baseline Sample
Baseline Health								
Depression	.340	.390*	.444***	.399	.355	.359	.587***	.378
	(.496)	(.508)	(.568)	(.538)	(.520)	(.503)	(.732)	(.546)
Physical Impairment	.115	.117	.336***	.229	.079	.040**	.342***	.099
	(.286)	(.302)	(.575)	(.472)	(.255)	(.148)	(.625)	(.311)
# of Life-Risky	.734	.703	1.059***	.898	.597	.588	1.165***	.650
Diseases	(.923)	(.878)	(1.113)	(1.034)	(.896)	(.892)	(1.192)	(.942)
Demographic Var.								
Age at Baseline Wave	65.298	65.811*	70.202***	67.883	57.878	56.934**	59.804***	57.940
	(4.486)	(4.781)	(6.730)	(6.256)	(4.813)	(4.708)	(4.824)	(4.847)
Cohort [Range]	1923.7*	1923.2	1918.8***	1921.1	1938.1	1939.1**	1936.2***	1938.1
	[1901, 1929]	[1905, 1929]	[1893, 1929]	[1893, 1929]	[1928, 1946]	[1926, 1946]	[1926, 1946]	[1926, 1946]
Female (%)	.475	.440	.393***	.429	.500	.505	.348***	.486
Mainlander (%)	.239	.376***	.186***	.226	.073	.070	.098^{+}	.075
Socioeconomic Var.								
Education Years	4.486	5.409***	3.637***	4.148	5.357	6.040**	5.272	5.436
	(4.438)	(4.933)	(4.279)	(4.451)	(4.380)	(4.441)	(3.936)	(4.352)
Having Child with 13+ Edu. Years (%)	.409	.457*	.301***	.358	.509	.528	.473	.508
Economic Hardship	1.089	1.065	1.207***	1.147	1.176	1.268**	1.372***	1.207
	(.674)	(.738)	(.722)	(.709)	(.578)	(.620)	(.704)	(.600)
Income Level (%)								
Highest Third	.343	.407**	.238***	.296	.170	.179	.112*	.166
Middle Third	.389	.376	.341**	.363	.252	.243	.138**	.240
Lowest Third	.257	.206*	.403***	.327	.373	.352	.545***	.386
Missing Info.	.012	.012	.017^{+}	.015	.206	.226	.205	.209
Employment (%)								
Having Jobs	.351	.371	.226***	.289	.512	.512	.308***	.493
Out of Labor Force	.493	.457	.634***	.562	.320	.342	.549***	.345
Never Worked	.155	.170	.139^{+}	.149	.168	.146	.143	.163
Occupation Prestige (%)								
Highest Third	.251	.333***	.241	.255	.290	.415***	.299	.307
Middle Third	.231	.129***	.271**	.241	.332	.209***	.362	.319
Lowest Third	.239	.278^{+}	.276**	.262	.367	.366	.330	.363
Missing Info.	.279	.261	.212***	.243	.010	.010	.009	.010
Non-Investor (%)	.122	.261***	.206***	.180	.104	.196***	.165**	.122
Social Relationships Var.								
Baseline Widow (%)	.222	.244	.326***	.278	.107	.106	.156*	.111
No living child (%)	.020	.031^{+}	.019	.021	.024	.037	.058**	.029

Live or Contact With Child Daily (%)	.803	.670***	.773*	.773	.843	.824	.795*	.836
Social Support	2.319	2.196***	2.222***	2.256	2.720	2.662*	2.629**	2.704
	(.435)	(.496)	(.470)	(.463)	(.449)	(.539)	(.550)	(.473)
Relationships Dissatisfy (%)	.248	.285^{+}	.286**	.272	.186	.219^{+}	.284***	.199
Familial Criticism Exposure	1.316	1.379**	1.322	1.326	1.340	1.379	1.424**	1.353
	(.420)	(.471)	(.428)	(.430)	(.509)	(.538)	(.539)	(.516)
Number of Cases	1,468	418	2,010	3,896	1,820	301	224	2,345

Note: The sample sizes of physical impairment, economic hardship, support, relationships dissatisfaction, critic within the family are 7, 48, 7, 15, 10 less than the total sample size listed—6,511—respectively.
$^{+}$ p < .10; * p < .05; ** p < .01; *** p < .001 (one-tailed t-tests for difference between means and one-tailed proportion test for difference between percentages by survival/attrition status; compared to respondents completed in all waves).

assets, stocks, savings, etc.). This implies that they have potential resources they can utilize when they need.

Among social relationships, the well-educated Taiwanese are less likely to be widowed at baseline or to have lost spouses across surveys, although they are also less likely to live with their children. The well educated have higher initial levels of social support and maintain social support at persistent high levels across surveys. In addition, the well-educated elderly report lower initial levels of relationships dissatisfaction and keep dissatisfaction levels low over time. However, it is important to note that the well-educated Taiwanese report higher levels of negative interaction; the well-educated elderly are even associated with higher levels of familial criticism exposure than their counterparts.

Last but not least, the well-educated Taiwanese apparently have lower levels of alienation in powerlessness, mistrust, normlessness, and meaninglessness. It appears that the well educated are less likely to be associated with psychological states that intensify distress.

Characteristics by Survival Statuses

Table 3.6 demonstrates that survivors and nonsurvivors in the elderly and middle-aged panel samples have very different characteristics. Compared with nonsurvivors, survivors are generally less depressed and physically healthier at baseline. They also are generally better educated, although survivors who did not complete all surveys are the highest educated. Meanwhile, survivors are also more likely to be younger, female, Mainlander (elderly samples only), not widowed, and co-reside with children. They have higher levels of social support and are less likely to have higher levels of economic hardship, relationships dissatisfaction and familial criticism exposure. They are at a lower risks of being low income and being out of the labor forces.

3. METHODS

1) The Cross-Sectional Age-Depression Model

The cross-sectional associations between depression and age are composed of several aging components that delineate various types of aging effects across the life course, depending on the age structure of the used samples. For instance, Equation (1) represents the age-depression model for the target population from early adulthood, beginning at 20, to late adulthood ending at 90:

$$\hat{D} = b_0 + b_1(Age - 20) + b_2(Age - 20)^2 + b_3(Age - 20)^3 + \sum_{b_i=4}^{k}\left(X_i - \overline{X}_i\right) \quad (1)$$

Equation (1) can be separated into the following components. To begin with, Equation (2) denotes the falling aging component that symbolizes the decline in depression in successively older age groups due to survival of healthy adults, rising social status associated with life stage, and maturity, etc. The intercept, b_0, represents the

predicted depression at the initial age of 20. And b_1 symbolizes the subsiding depression with increasing age after the initial age (assuming the intercept is positive and the regression coefficient is negative).

$$D_f = b_0 + b_1(Age - 20) \tag{2}$$

Equation (3) shows the rising aging component representing the growth of depression (assuming the coefficient of b_2 is positive) in successively older age groups resulting from lower education among older cohorts, from the loss of social statuses associated with life stage, and from declining physical health in the late adulthood, etc. The square function of age and its slope are zero at age 20 when *(Age-20)* is zero. The derivative of the rising square curve is $2b_2(Age-20)$, so the upward slope rises at the stable rate with advancing age.

$$D_r = b_2(Age - 20)^2 \tag{3}$$

Equation (4) is the falling aging component that represents the late-life depression decrease resulting from differential survival among the elderly population (assuming the coefficient of b_3 is negative). The derivative of the late life falling curve is $3b_3(Age-20)^2$, so the downward slope gets steeper with advancing age.

$$D_{LateLifeFall} = b_3(Age - 20)^3 \tag{4}$$

Finally, the last component of the Equation (1) represents adjustments for fixed and changing traits, all of which are measured as a deviation from their sample means. For dichotomous variables, the mean equals the proportion of the sample with the categorical attribute. As a result, the intercept b_0 represents the predicted depression at age 20 if the control variables equal their sample means.

2) Age-Cohort OLS Regression Model

With the repeated cross-section TSCS data, this research intends to describe predicted depression among individuals from the same cohort at different phases across age. The age-cohort regression models (with period omitted) is:

$$\hat{D} = b_0 + b_1 Age + b_2 Age^2 + b_3 Cohort + b_4 AgeCohort + b_5 Edu + b_6 AgeEdu + b_7 Age^2 Edu + b_8 CohortEdu + b_9 AgeCohortEdu + b_{1c} ControlVar \quad (5)$$

This model shows that the effects of education on depression differ across age (see age-education interaction term), across cohorts (see cohort-education interaction term), and are nonlinear across age (see age^2-education interaction term). The three-way interaction among age, cohort, and education permits the position of the quadratic age-education patterns to vary across cohorts.

This model can be rewritten to emphasize the sum of coefficients contingent on education:

$$\hat{D} = (b_0 + b_1 Age + b_2 Age^2 + b_3 Cohort + b_4 AgeCohort + b_{10} ControlVar) + (b_5 + b_6 Age + b_7 Age^2 + b_8 Cohort + b_9 AgeCohort) Edu \quad (6)$$

In other words, "$b_5 + b_6 Age + b_7 Age^2 + b_8 Cohort + b_9 AgeCohort$" is regarded as the total effects of education on depression.

3) Aging Vector Model

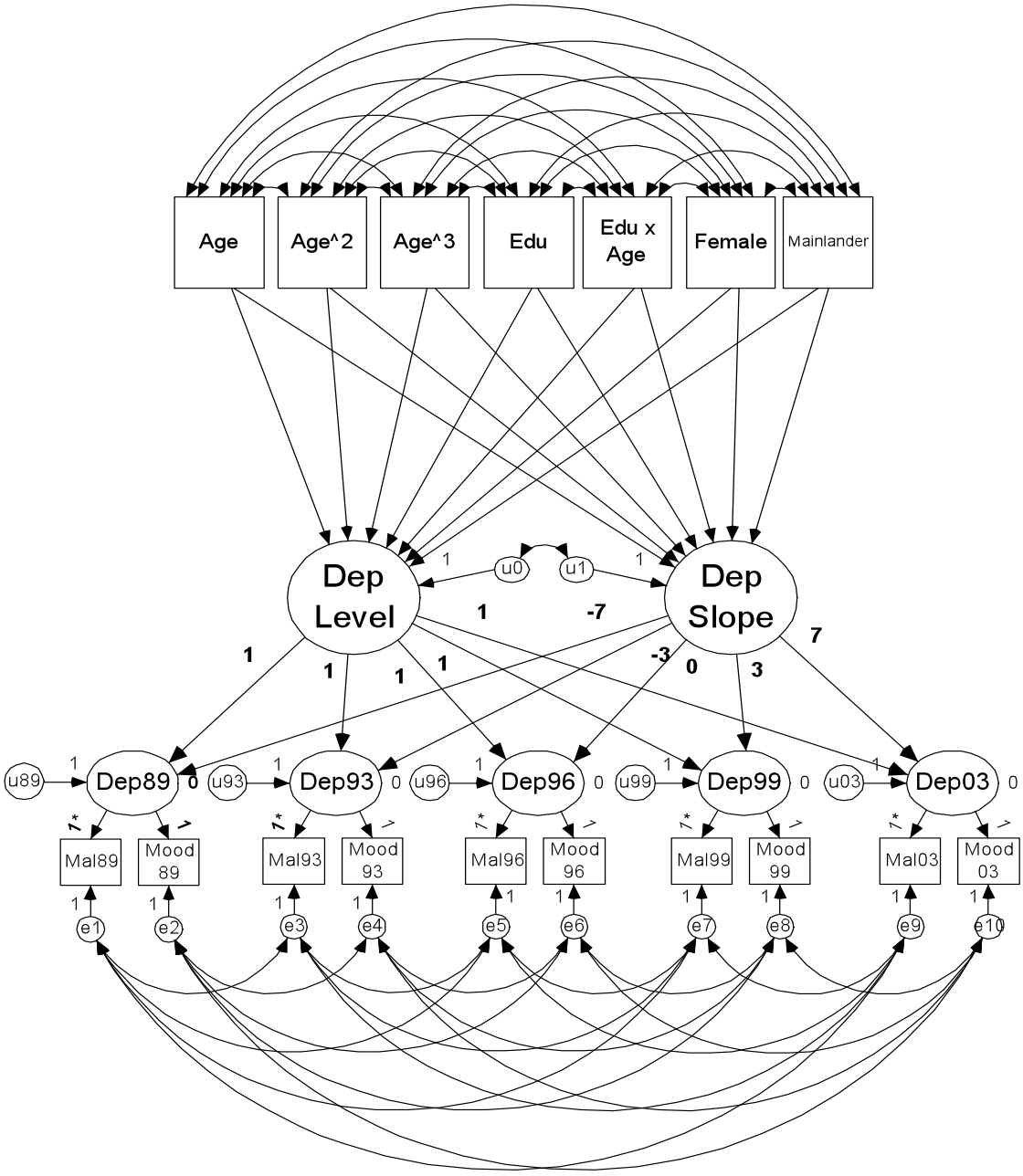
The aging vector model is a newly-developed analytical approach designed to delineate a composite image of the outcome's life course trajectory across follow-up periods, although its roots can be traced back to developmental psychology's accelerated longitudinal designs (Bell 1953; Mirowsky and Kim 2007; Miyazaki and Raudenbush

2000). In brief, aging vector models enable researchers to estimate the origins and slopes of changes of outcomes during the follow-up periods as functions of age at the time. This allows researchers to illustrate the impacts of personal traits such as education on the trajectory, and to display the shape of deviations from the general pattern (Mirowsky and Kim 2007).

Aging vector models provide two specific characteristics that reduce the model misspecification error and estimation bias resulting from the ignorance of the confounding life-course and cohort effects, and mortality selection (Lauderdale 2001; Lynch 2003; Mirowsky and Kim 2007). First, aging vector models distinguish life course trajectories from inter-cohort trends by predicting both the level of an outcome at the beginning or middle of a period and the slope of changes with respect to time throughout the period, each adjusted for the other. In other words, it allows age at baseline or mid-follow-up to appear in the between-person equations that delineate how the passing of time influences within-person changes from baseline levels. This allows researchers to facilitate the inter-cohort comparison of the age-specific vector slopes (Mirowsky and Kim 2007). Second, the aging vector models correct for missing values based on all available data regardless of their status in the follow-up interviews via an estimating approach called Full-Information Maximum Likelihood (FIML), as detailed in a later section. The health trajectories of individuals who dropped out due to death or other reasons can still be estimated. Mortality selection bias is thus reduced (Lynch 2003; Wothke 2000).

The basic aging-vector model has three sets of equations: within-person equations, between-person equations, and measurement equations. Figure 3.1 illustrates the prototypical form with only respect to age functions, education, the interaction term

Figure 3.1: Path Diagram Representing the Structural Equation Model.



of education and age, and demographic control variables, which corresponds to the following sets of equations.

Within-Person Equations

Equation (7) describes that the depression outcome D for person i at time t is a linear function of time plus an error term e_{it} that is random with respect to time. a_{i0} and a_{i1} represent the origin level of predicted depression at the wave designated at time zero and slope of predicted depression over the follow-up period.

$$D_{it} = a_{i0} + a_{i1}t + e_{it} \tag{7}$$

The most important characteristic of Equation (7) is that it analyzes changes with respect to time rather than age. It means that the within-person equation indicates the effect of aging t years rather than the effect of the age differences at different times of interviews. This approach allows age at the designated time to appear in the between-person model. Hence, the effects of aging t years depend on age at the time of the study.

Equation (8) demonstrates that time (t) can be measured as the difference between the calendar year of the survey wave and the calendar year of the wave designated at time zero, which equals the difference between age at the time of an observation and age in the reference year. As implied in Equation (8), age effect is confounded with period effect in any panel design.

$$t = S_t - S_0 = A_{it} - A_{i0} \tag{8}$$

This model demonstrates two latent factors, the level and slope in depression. The level factor has a fixed effect of 1.0 on the depression level reported in five waves. The

slope factor has fixed effects that center on the middle of the follow-up survey periods, which measures time as a deviation from the middle of the follow-up period. It means the 0 year of change in 1996, less 7 and 3 years in 1989 and 1993, and by 3 and 7 years in 1999 and 2003, respectively.

Between-Person Equations

Equation (9) predicts that the individual's origin of depression are functions of age at time zero (A_{io}) centered on a reference age 70 (linear, squared or cubic terms), of education centered on 6 education years (negative sign means education decreases depression), of controlled covariates, and of individual random deviations u_{io} from the expected value, describing cumulative effects up to that wave. Equation (10) describes that subsequent change over the period depends on these effects and a residual $u_{i1,}$ with the adjustment for the accumulation of the effects. The interaction term between education and age is added into both between-person equations to examine the patterns of divergence or of convergence. The negative sign of the interaction term indicates that the effects of education on depression level or slope increase with age, suggesting divergence in depression; the positive sign means that effects decrease with age, suggesting convergence in depression; and the insignificant term shows that the effects are the same in all age groups.

The between-person dependent variable can be defined as a vector representing the origin, direction, and amount of change throughout the follow-up period. These two between-person equations are further used as linear approximations to the curve over each segment of adulthood and as estimates of the slope of that curve at each segment's midpoint. Moreover, since functions of age at time zero are specified as fixed-effect components of the two between-person equations rather than appearing in the within-

person equation, the age functions can take any form, with any number of them appearing in any combination. As a consequence, the effect of aging t years depends on age—appearing as different forms (such as linear or quadratic terms) that represent different type of aging effects—at the time of the study (Mirowsky and Kim 2007; Mirowsky and Ross 2007).

$$a_{io} = a_{00} + a_{01}(E-6) + a_{02}(A_{i0}-70) + a_{03}\left(A_{io}-70\right)^2 + a_{04}(E-6)\times(A_{io}-70) + a_{0c}ControlVar + u_{io} \quad (9)$$

$$a_{i1} = a_{10} + a_{11}(E-6) + a_{12}(A_{i0}-70) + a_{13}(A_{i0}-70)^2 + a_{14}(A_{i0}-70)^3 + a_{15}(E-6)\times(A_{io}-70) + a_{1c}ControlVar + u_{i1} \quad (10)$$

Furthermore, Equation (11) clarifies that age at time zero (A_{i0}) is the difference between the calendar year of the survey at time zero (S_0) and the individual's birth year (B_i), representing the confounding relationship among age, cohort, and period. It means that the reference age A_{i0} in equations (9) and (10) is the age in year S_0 (the reference year $t = 0$) of a reference cohort. In other words, age at time zero can also represent the cohort. For instance, persons aged 70 in the survey year 1996 were all born in 1926.

$$A_{i0} = S_0 - B_i \quad (11)$$

Measurement Equations

The following set of equations represents the relationship between latent factors of depression and its observed indicators, describing the scores on subscales of mood and malaise as linear functions of the latent depression. Equation (12) has an intercept fixed to zero and a slope fixed to 1, setting the metric of the latent factor to that of the mood subscale. Equation (13) describes the effect of mood on malaise. The slope (the "1*"

loading in the Figure 3.1) means that malaise will move up or down parallel with mood but by a proportional amount that may be larger or smaller than 1.0.

$$D_{mood_{it}} = D_{it} + e_{D_{mood\_it}} \tag{12}$$

$$D_{malaise_{it}} = \lambda_0 + \lambda_1 D_{it} + e_{D_{mailaise\_it}} \tag{13}$$

Graphing Aging Trajectories and Inter-Cohort Trends

Aging-vector models estimate the changes of outcome that occur as individuals age across segments of the life course. Nonetheless, the implications of the two between-person equations at the same time make the comprehension and expression of the regression estimations difficult even for the most experienced quantitative sociologists. As a result, vector graphs are designed to decipher the equations and represent the shape of the progression of outcome over the life course. Meanwhile, the vectors reveal trends in the age-specific levels and slopes of the outcome (Mirowsky and Kim 2007).

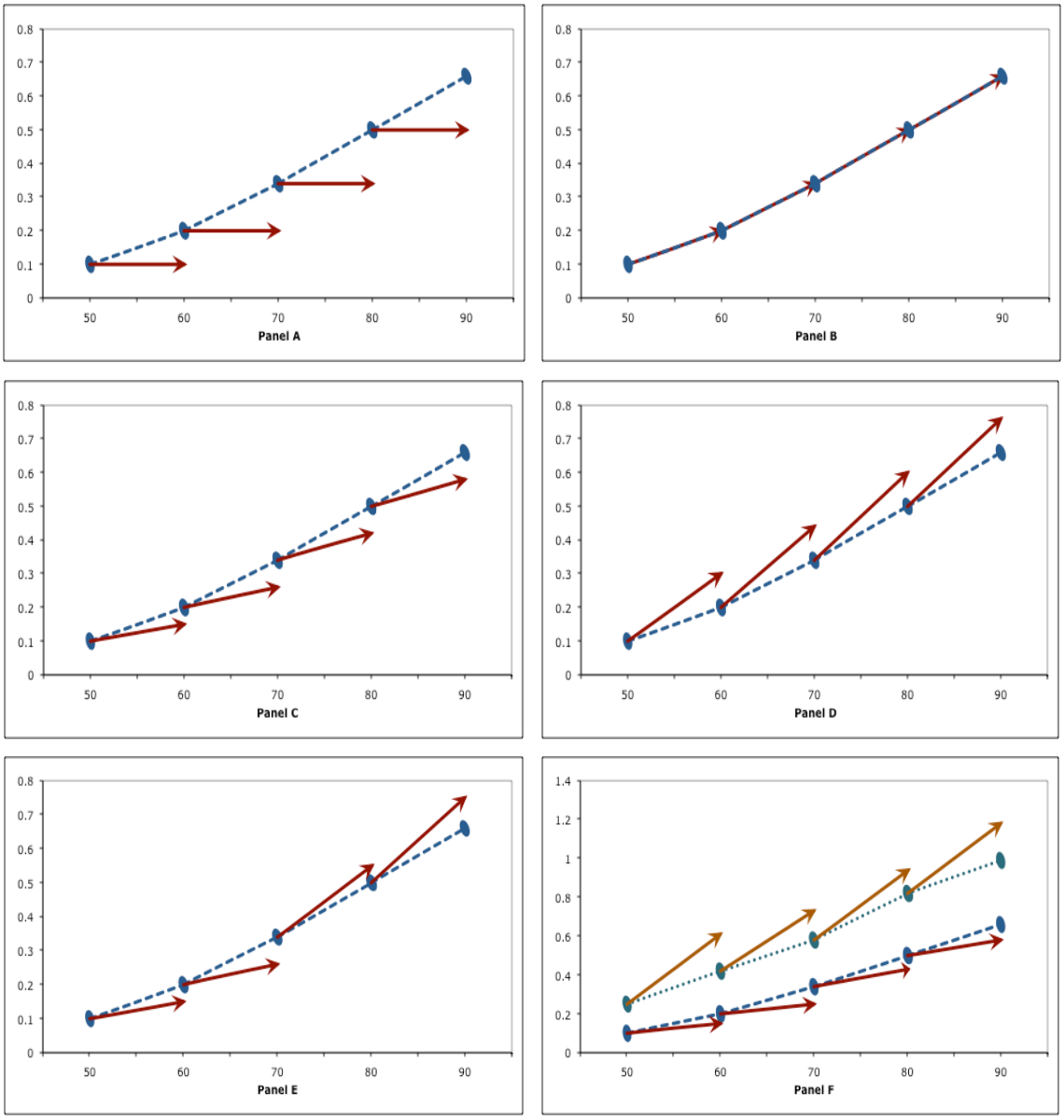
Figure 3.2 illustrates six hypothetical sets of aging vectors with the same set of origins on a cross-sectional age curve. The vectors represent the predicted values of depression from an imaginary 10-year study for individuals aged 50 and above to correspond to the middle-aged and elderly panel samples this research actually utilizes. The Y-axes of the graphs represent the predicted depression and the X-axes represent age. Besides, consistent with the findings based on the previous cross-sectional research, depression increases with age in late adulthood. To simplify, the following graphs show only every 10th vector. Mathematically speaking, vectors of change do not necessarily correspond closely to the shape of a cross-sectional age curve. For instance, Panel A displays no aggregate change in any baseline age group, but newer cohorts have lower

age-specific levels of depression in late adulthood (at age 60 the arrowhead is below the circle). In general, the shape of aging vectors corresponds to the shape of the cross-sectional aging curve. Panel B indicates an example of perfect conformity between the vectors and the cross-sectional curve. Each arrowhead ends where the next one begins. It means age-specific changes are consistent across cohorts. Inter-cohort trends are thus nonexistent.

Panel C shows a favorable inter-cohorts trend in an undesirable outcome such as depression. Every newer cohort has lower age-specific levels of depression (arrowheads below circles at every age). It means that the trend is toward lower age-specific levels and more negative age-specific slopes in newer cohorts. Conversely, Panel D represents an unfavorable trend in depression. Newer cohorts display higher age-specific levels of depression (arrowheads above circles at every age), although vectors are consistent with the cross-sectional pattern.

In some cases, inter-cohort trends favor certain age groups but disfavor the others. For instance, Panel E demonstrates that trends favor the middle-aged (arrowheads below circles at age 60 and age 70) but disfavor the elderly (arrowheads above circles at age 80 and 90). Moreover, it is possible that inter-cohort trends vary across different social statuses. As indicated in Panel F, the higher vectors and the higher cross-sectional aging curve can be regarded as the predicted depression across segments of the life course for Group 1; while the lower vectors and the lower cross-sectional aging curve present predicted depression for Group 2. Both groups demonstrate similar cross-sectional patterns. However, they have opposite inter-cohort trends. An unfavorable trend generally appears within Group 1 (arrowheads above circles at every age); while a favorable trend appears within Group 2 (arrowheads below circles at every age).

Figure 3.2: Aging-Vector Graphs Illustrating Six Hypothetical Relationships between a Cross-Sectional Curve (Dash Lines with Circles) and Vectors of Change During a 10-Year Follow-Up (Solid Lines with Arrowheads).



3) Resource Substitution/Multiplication Model

The following between-person equation models add various disadvantageous statuses (in economic resources or social relationships). The comparison between coefficients of education in the models without and with these disadvantageous statuses demonstrates whether educational effects on either depression level or slope are mediated by these disadvantageous statuses.

Furthermore, the interaction term between education and disadvantageous status is added into the model to examine whether the strength of education-depression association is contingent on disadvantageous status. The negative sign of interaction term indicates that the effects of education on depression level or slope are greater for those with certain disadvantageous status or having higher level in that certain disadvantage, thus supporting the resource substitution theory; the positive sign indicates that the effects of education on depression level or slope are smaller for those with certain disadvantageous status or with higher level in that certain disadvantage, thus supporting the resource multiplication theory; and an insignificant sign indicates that the effects of education are the same in all status groups.

$$a_{io} = a_{00} + a_{01}(E-6) + a_{02}(A_{i0}-70) + a_{03}\left(A_{io}-70\right)^2 + a_{04}DS + a_{05}(E-6)\times DS + a_{0c}ControlVar + u_{io} \tag{14}$$

$$a_{i1} = a_{10} + a_{11}(E-6) + a_{12}(A_{i0}-70) + a_{13}(A_{i0}-70)^2 + a_{14}(A_{i0}-70)^3 + a_{15}DS + a_{16}(E-6)\times DS + a_{1c}ControlVar + u_{i1} \tag{15}$$

4) Survival Hazard Model

Equation (16) displays the maximum likelihood survival regression with a Gompertz hazard distribution. The Gompertz distribution has been suggested to be predominately suitable for investigating old-age mortality and is thus appropriate for the Taiwanese elderly sample (Zimmer, Martin, and Lin 2005; Zimmer et al. 2007). Survival status for each respondent has been linked to a registry that provides the date of death for individuals who died since their baseline interview. Of the total 4,049 respondents contacted in the baseline interview of the 1989 elderly sample, only 36 respondents provide incomplete information about their survival status and were thus excluded from the following survival analysis with the Gompertz distribution. Survivors until the last interview were right-censored, with survival time being the time between the first interview and the last known date of survival.

$$h_{jk}(t) = \exp[\beta_{jk} X_i(t) + \gamma t] \tag{16}$$

A series of models are developed with a progressive adjustment principle. To begin with, mortality hazards are modeled as a function of depression. Education, demographic variables, physical impairment, and the number of life-threatening diseases are further added in the following models. Differences in log-likelihoods between two models are utilized to judge whether a set of added variables improves prediction of survival.

Chapter 4: Depression in Taiwan: The Cross-Sectional Aging Trajectories

1. HYPOTHESES

Utilizing the cross-sectional data from the 1990, 1995, 2000, and 2005 TSCS samples, the 1996 middle-aged sample, and the 1989 elderly sample, this chapter aims to denote the composite image of aging trajectories in depression over the life course in Taiwan. Furthermore, this chapter ascertains five theoretical perspectives in explaining the cross-sectional relationships between age and depression: "age as historical trends," "age as differential survival," "age as life stage," "age as maturity," and "age as decline". Two sets of hypotheses are established according to the relevant theories and descriptive statistical findings detailed in previous chapters.

1) The Cross-Sectional Aging Trajectories in Depression

The "U-shape trajectories" hypothesis: the levels of depression (depressed mood and malaise) decline in early adulthood, bottom out in middle age, and then rise again in old age.

The "Falling late-life trajectories " hypothesis: the levels of depression decline among the oldest-old in the sample that includes respondents across the entire adulthood.

The "Rising late-life trajectories" hypothesis: the levels of depression (depressed mood and malaise) rise in late life in the elderly-specific sample.

2) Five Aging Views

"Age as historical trends" hypothesis: average levels of depression are higher in successive older age groups, and the adjustment of favorable trends toward younger generations—such as education, children's education, and financial investment—partially explain the rising aging trajectories in depression in late life.

"Age as differential survival" hypothesis: the first form is that depression declines across the life course and adjusting for socioeconomic and marital statuses accounts for some of the falling curve; the second form is that depression increases in old age and adjusting for sex explains some parts of the rising curve.

"Age as life stage" hypotheses: average levels of depression decline from early adulthood to middle age and then increase again in late life. Adjusting for economic conditions, employment, and marital status eliminates some of the decline and followed by rise in depression over the life course.

"Age as maturity" hypothesis: average levels of depression decrease in successively older age groups, and the adjustment of negative interaction and relationships dissatisfaction partially explain the falling aging curve in depression.

"Age as decline" hypothesis: average levels of depression increase at an accelerating rate in progressively older age groups, controlling for physical impairment, chronic diseases, and powerlessness that all account for some of the age variations in depression.

2. THE CROSS-SECTIONAL LIFE COURSE PATTERNS IN DEPRESSION

Does depression change over the life course in Taiwan? Table 4.1 presents the empirical patterns derived from six cross-sectional samples with different age structures—including the 1990, 1995, 2000, and 2005 TSCS, the 1989 elderly sample,

and the 1996 middle-aged sample—and suggests the consistent parabolic life course patterns of depression. Figure 4.1 and Figure 4.2 illustrate the corresponding statistical results. Taken as a whole, depression falls and then rises in successive age groups. Depression is lowest in the middle age groups (around ages 40 to 60) and is higher in early adulthood (roughly before age 30) and in late life (roughly after age 70). The regression results of depression fit aging trajectories that reflect the same underlying patterns as the means, such as those indicated in Table 3.1 and Table 3.2 and in the right graphs of Figure 4.1 and Figure 4.2.

Two specific conditions are noteworthy. First, the pooled TSCS sample demonstrates that depression declines after age 85. It is probably the false impression resulted from mortality selection, which commonly appears in the cross-sectional analyses. The elderly over age 85 in the pooled TSCS data (26 out of total 8,639 respondents) are the most less-depressed or physically healthiest survivors, making aging in late adulthood appears beneficial when it is actually deleterious. In essence, the mean of age-specific depression increases with age among those 26 oldest-old. In addition, depression still increases with age among those elderly who have already been less depressed than their deceased counterparts in the elderly-specific sample, as indicated in Figure 4.2. The survival analyses in the next chapter will further elaborate on the impacts of mortality selection.

Second, the 1990 TSCS sample (with the ages ranging from 20 to 64) and the 1996 middle-aged sample (with the ages ranging from 50 to 70) both reveal that average depression declines as individuals approach the age of retirement transition (around ages 60 to 70), as shown in the right graphs of Figure 4.1 (the 1990 sample) and Figure 4.2 (the 1996 sample). Nonetheless, the declining depression here is probably tentative. The

Table 4.1: Depression (Square-Root) Regressed on Aging Components on Cross-Sectional Samples: Taiwan, TSCS (1990, 1995, 2000, and 2005), the 1989 Elderly Baseline Sample, and the 1996 Middle-Aged Baseline Sample.

	TSCS					Elderly & Middle-Aged		
Variables	1990 [a]	1995 [a]	2000 [a]	2005 [a]	Pooled	1989	1996	Pooled
Initial D. [b]	.638***	.654***	.662***	.695***	.662***	.411***	.301***	.332***
Age (10^{-2})	-2.199***	-.855**	-.548*	-.417*	-1.036***	.543***	2.553***	1.452**
	(-3.664)	(-3.455)	(-2.343)	(-2.129)	(-4.377)	(4.838)	(3.643)	(2.974)
Age^2 (10^{-3})	1.042**	.132**	.083*	.054$^+$	.294**		-.935*	-.565$^+$
	(3.094)	(2.981)	(2.019)	(1.652)	(3.251)		(-2.281)	(-1.753)
Age^3 (10^{-5})	-1.399**				-.231*			.925
	(-2.645)				(-2.338)			(1.515)
R^2	.006	.007	.003	.003	.004	.006	.014	.009
N	2,530	2,073	1,879	2,131	8,639	3,896	2,345	6,241

Notes: Unstandardized coefficients with t-statistics in parentheses shown.

a. The age range of the 1990, 1995, 2000, and 2005 TSCS are [20-64], [20-75], [21-91], and [19-97], respectively. In the 2000 and 2005 analyses, 12 and 14 individuals over age 85 are omitted, respectively.

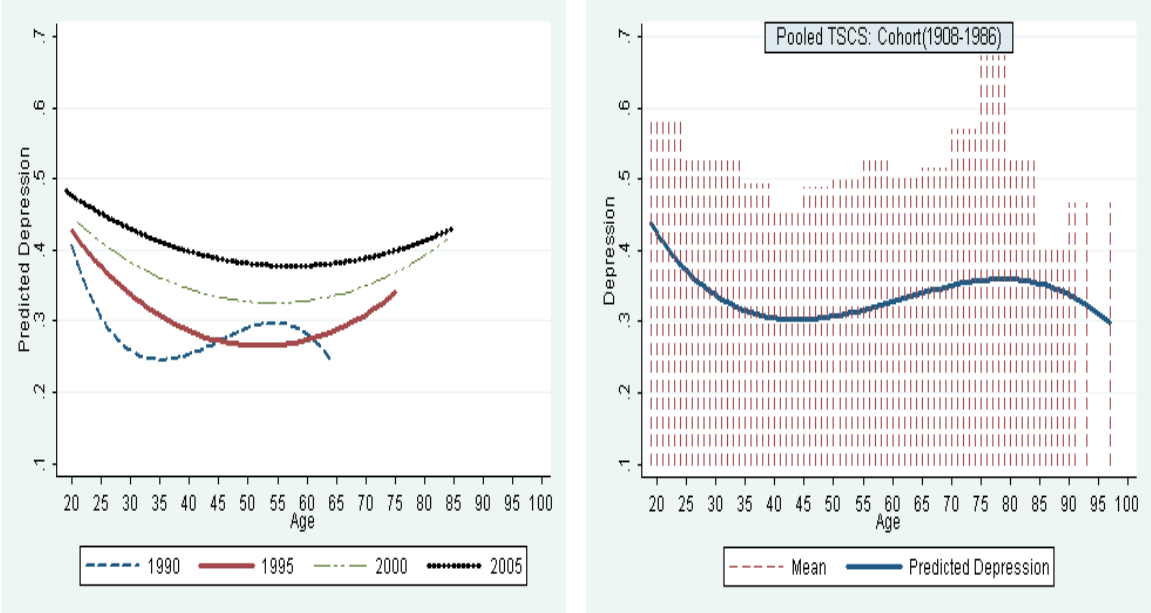
b. The intercept represents the predicted depression score at the initial age for the average respondent. The initial age of the 1990, 1995, 2000, and 2005 TSCS, the 1989 Elderly Sample, and the 1996 Middle-Aged Sample, are 20, 20, 21, 19, 60, and 50, respectively. Negative coefficients of aging components present falling aging curve while positive coefficients display rising age curve. The aging components are all measured as a deviation from its initial age.

$^+$ $p < .10$; * $p < .05$; ** $p < .01$; *** $p < .001$.

results based on the samples with wider age range—such as samples including individuals over age 70—display that depression keeps rising after around age 65.

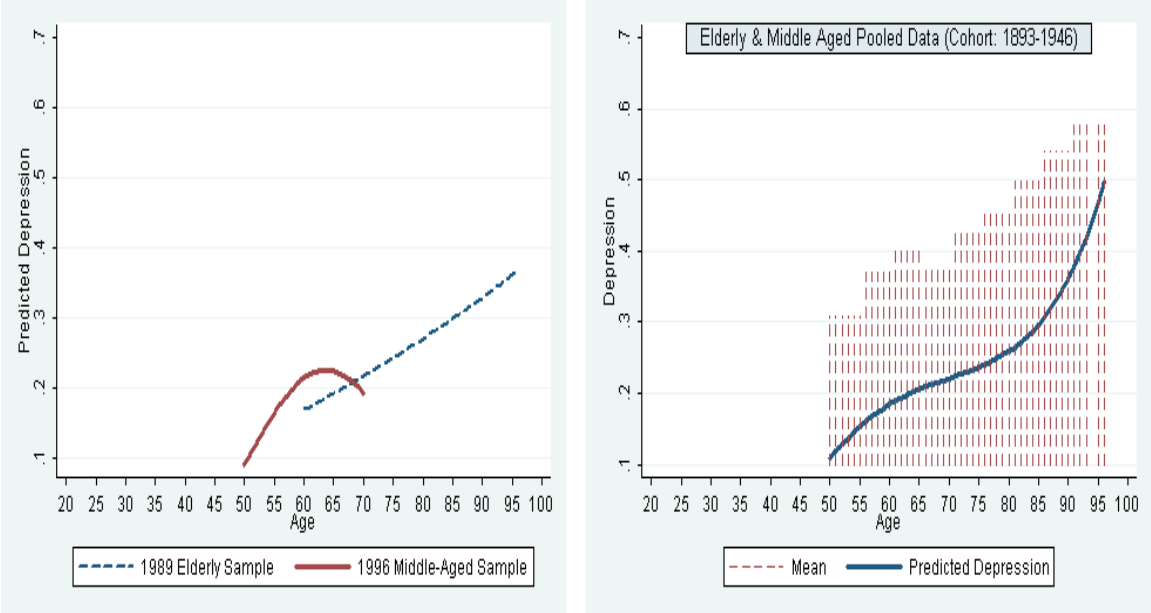
The results based on these six samples denote the general pattern of age-group differences in depression in Taiwan and generally support the aging trajectories hypotheses. However, they also demonstrate that the more recent samples indicate higher levels of symptoms of depression. The finding implies that average levels of depression vary across birth cohorts. This underlines the importance of integrating the life course and cohort perspectives in the folling empirical analyses in Taiwan.

Figure 4.1: Predicted Depression (4-items Index; Square of the Predicted Value in Models) Over the Life Course: Taiwan, TSCS, 1990, 1995, 2000, and 2005.



Note: In the pooled data, only 26 out of 8639 cases are over age 85.

Figure 4.2: Predicted Depression (8-items CESD Index) Over the Late Adulthood: Taiwan, the 1989 Elderly Baseline Sample and the 1996 Middle-Aged Sample.



3. FIVE AGING VIEWS

This research further utilizes the data drawn from the 2005 TSCS (ranging in ages from 19 to 85), the 1996 middle-aged sample (ranging in ages from 50 to 70), and the 1989 elderly sample (ranging in ages from 60 to 96) to elaborate whether the cross-sectional life course patterns of depression are attributable to the five aging views.

1) Historical Trends Components

Average levels of depression decline as average levels of education increase in successive Taiwanese generations. As a result, the growth of depression in late life actually reflects cohort differences—the elderly report higher levels of depression because they are the generations with lower average levels of education. In the 2005 TSCS sample, the 1996 middle-aged sample, and the 1989 elderly sample, 44% (100 x [.061-.034]/.064, from Model 2 to Model 3 of the coefficient of Age^2 in Table 4.2), 34% (100 x [2.340-1.555]/2.340, from Model 2 to Model 3 of the coefficient of *Age* in Table 4.3), and 34% (100 x [.456-.302]/.456, from Model 2 to Model 3 of the coefficient of *Age* in Table 4.4) of the rising curve vanish with the adjustment of education, respectively. The coefficients of the rising aging effects even become nonsignificant in the first two samples. The above empirical findings support the argument that educational trends account for a substantial part of the rising curve. Figure 4.3 and Figure 4.4 further display the corresponding life course trajectories of depression in these three samples. The consistent patterns are illustrated. Compared with the original trajectories (Model 1), the adjustment for education (Model 3) noticeably flattens the rising curve in late life.

Similarly, average levels of children's education and average percentages of having financial investment also increase in successive generations of Taiwanese, both of

which partially explain the rising curve in depression in late life. In the 1989 elderly sample, 32% (100 x [.302-.207]/.302, from Model 3 to Model 4 of the coefficient of *Age* in Table 4.4) of the rising curve in depression vanishes after the adjustment of having children with more than 13 education years and having financial investments.

Taken as a whole, the historical trends in education, children's education, and financial investment explain the substantial part of rising curve of depression in late life. These findings underscore the importance to consider the cohort effects in the life course research in Taiwan.

2) Survival Components

Many social statuses and conditions that produce depression also reduce survival. As a result, low survival among the most depressed social groups—such as individuals with low socioeconomic status and lacking social relationships resources—leads to an obvious decline in depression over the life course. Nonetheless, in the 2005 TSCS sample, economic hardship, low income, and unemployment do not explain the falling curve in depression (compared the coefficient of *Age* of Model 3 and Model 4 in Table 4.2), although marital status reduces 4% (100 x [-.723-(-.691)]/-.723, from Model 4 to Model 5 of the coefficient of *Age* in Table 4.2) of the falling curve. Thus, survival traits are not the major factors that lead to depression decline over the life course in Taiwan.

Meanwhile, sex accounts for part of the rising trajectories in depression through differential survival. Females are not only more depressed but also survive longer than males. In the 1996 middle-aged sample and in the 1989 elderly sample, the adjustment of sex (and ethnicity) reduces 8% and 16% of the rising curve (comparing the coefficient of Model 1 to those of Model 2 in Table 4.3 and Table 4.4, respectively). It reflects that

Table 4.2: Progressive Adjustment: Depression (Square-Root) Regressed on Aging Components and Variables Representing Five Aging Views: Taiwan, 2005 TSCS (N = 2,131).

Variables	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8
Initial D. [a]	.695***	.698***	.780***	.775***	.776***	.748***	.749***	.740***
Age (10^{-2})	-.417*	-.454*	-.677***	-.723**	-.691*	-.541*	-.516+	-.348
	(-2.129)	(-2.324)	(-3.461)	(-3.271)	(-2.522)	(-1.989)	(-1.909)	(-1.332)
Age^2 (10^{-3})	.054+	.061+	.034	.051	.041	.031	.031	-.006
	(1.652)	(1.846)	(1.026)	(1.366)	(.975)	(.739)	(.741)	(-.143)
Age as Survival								
Female (=1)		.075***	.047*	.049*	.041*	.035+	.041*	.017
		(3.902)	(2.431)	(2.376)	(1.967)	(1.718)	(1.998)	(.877)
Mainlander [b]		-.051	.001	.013	.014	-.002	.003	-.007
		(-1.592)	(.034)	(.405)	(.443)	(-.049)	(.103)	(-.230)
Age as Cohort								
Education [c]			-.197***	-.094**	-.087**	-.090**	-.070*	-.044
			(-7.091)	(-3.193)	(-2.966)	(-3.101)	(-2.403)	(-1.569)
Age as Life Stage								
Economic				.094***	.094***	.089***	.078***	.065***
Hardship				(9.872)	(9.857)	(9.411)	(8.179)	(6.976)
Lowest 3rd				.027	.022	.014	.016	.020
Income [d]				(1.208)	(.970)	(.623)	(.715)	(.917)
Missing				.011	.010	.018	.014	-.001
Income [d]				(.290)	(.260)	(.467)	(.373)	(-.016)
Unemployed [e]				.042	.034	.029	.034	.012
				(1.022)	(.829)	(.695)	(.828)	(.303)
Student [e]				-.049	-.049	-.053	-.044	-.028
				(-1.103)	(-1.106)	(-1.201)	(-1.000)	(-.666)
Housewife [e]				.021	.028	.036	.035	.049
				(.685)	(.875)	(1.165)	(1.122)	(1.625)
Retired [e]				-.019	-.020	-.009	-.006	-.007
				(-.468)	(-.515)	(-.228)	(-.163)	(-.191)
Single [f]					.004	.014	.021	.012
					(.127)	(.421)	(.648)	(.367)
Divorced [f]					.101+	.100+	.100+	.078
					(1.794)	(1.798)	(1.820)	(1.458)
Widowed [f]					.096*	.108*	.105*	.110**
					(2.186)	(2.459)	(2.416)	(2.632)
Age as Maturity								
Support						-.025*	-.021+	-.019
						(-1.991)	(-1.690)	(-1.559)
Negative						.078***	.078***	.067***
Interaction						(6.341)	(6.346)	(5.613)
Age as Decline								
Powerlessness							.030***	.028***
							(5.893)	(5.732)
Physical								.168***
Impairment								(12.480)

R^2	.003	.012	.035	.085	.089	.109	.123	.184

Notes: Unstandardized coefficients with t-statistics in parentheses shown.
a. The intercept represents the predicted depression score at the initial age, 19, for the average respondent. The intercept and Age present falling aging curve while Age^2 displays rising age curve. Aging components are measured as a deviation from the initial age.
b. Compared to other three Taiwanese ethnic groups: Ho-lo, Hakka, and Aboriginals.
c. Education years is modeled as (Education – the sample mean of education) x 10^{-1}.
d. Compared to respondents who are equal or over the middle third of the household income level.
e. Compared to respondents who are currently employed.
f. Compared to respondents who are currently married.
$^{+}$ p < .10; * p < .05; ** p < .01; *** p < .001.

differential survival between males and females partially explain the rising depression in late life, as indicated in the right graph of Figure 4.4.

3) Life Stage Components

Middle-aged people are less likely to be depressed because they tend to have established economic resources, employment, and marriage. Conversely, loss of spouse and retirement lead to depression deterioration in late life. As a consequence, adjusting for economic resources, employment, and marital status raises middle-aged depression and eliminates the late-age growth in depression. Figure 4.4 illustrates the aging trajectories of depression with the adjustment of these life-course statuses found in the 1996 middle-aged sample and the 1989 elderly sample (corresponding to Model 5 in Table 4.3 and Table 4.4). Compared with the original trajectories in depression (Model 1 in both graphs), the trajectories with the adjustment of life-stage statuses (Model 5 in both graphs) elevate in middle age and drop in late adulthood, suggesting that the life-stage statuses explain the psychological advantages of middle age and disadvantages of old age. Similar patterns are found in the 2005 TSCS sample. Nonetheless, the effects of the life stage statuses on shaping aging trajectories are smaller than the effects of education. Adding the adjustment of the life stage statuses (Model 5) only slightly

Table 4.3: Progressive Adjustment: Depression (Square-Root) Regressed on Aging Components and Variables Representing Four Aging Views: Taiwan, the 1996 Middle-Aged Sample (N = 2,345)

Variables	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8
Initial D. [a]	.301***	.304***	.340***	.340***	.371***	.363**	.390***	.387***
Age (10^{-2})	2.553***	2.340**	1.555*	1.675*	1.476*	1.469*	1.143^{+}	1.084^{+}
	(3.643)	(3.344)	(2.219)	(2.400)	(2.185)	(2.189)	(1.798)	(1.699)
Age^2 (10^{-3})	-.935*	-.772^{+}	-.463	-.579	-.629	-.649	-.659^{+}	-.625^{+}
	(-2.281)	(-1.860)	(-1.121)	(-1.408)	(-1.582)	(-1.647)	(-1.766)	(-1.668)
Age as Survival								
Female (=1)		.133***	.081***	.089***	.083***	.085***	.081***	.079***
		(7.233)	(4.132)	(4.481)	(3.955)	(4.097)	(4.117)	(3.970)
Mainlander		-.012	.039	.015	.026	.014	.014	-.002
(=1)		(-.329)	(1.049)	(.407)	(.716)	(.388)	(.413)	(-.058)
Age as Cohort								
Education [b]			-.167***	-.139***	-.082**	-.080**	-.065**	-.054^{+}
			(-7.169)	(-5.624)	(-3.283)	(-3.239)	(-2.753)	(-1.722)
H-Educated				-.038^{+}	-.008	-.001	-.019	-.017
Child [c]				(-1.956)	(-.397)	(-.075)	(-1.037)	(-.931)
No Child [c]				.097^{+}	.072	-.009	.016	.020
				(1.734)	(1.340)	(-.150)	(.293)	(.370)
Non-Investor				.110***	.058*	.049^{+}	.032	.033
(=1)				(3.941)	(2.110)	(1.786)	(1.248)	(1.270)
Age as Life Stage								
Economic					.172***	.157***	.127***	.127***
Hardship					(11.173)	(10.108)	(8.584)	(8.569)
Lowest 3rd					.021	.012	.005	.006
Income [d]					(.936)	(.561)	(.258)	(.268)
Missing					.038	.031	.036	.037
Income [d]					(1.536)	(1.259)	(1.568)	(1.579)
Out of Labor					.094***	.095***	.042*	.043*
Force [e]					(4.476)	(4.515)	(2.088)	(2.123)
Never Work [e]					-.001	-.008	-.038	-.038
					(-.016)	(-.269)	(-1.421)	(-1.445)
Widowed (=1)					.062*	.054^{+}	.064*	.064*
					(2.181)	(1.882)	(2.392)	(2.373)
Age as Maturity								
Support						-.065**	-.063**	-.063**
						(-2.971)	(-3.029)	(-3.009)
Relationship						.091***	.085***	.085***
Dissatisfy [f]						(3.595)	(3.514)	(3.537)
Child						-.027	-.032	-.032
Contact [g]						(-1.074)	(-1.336)	(-1.352)
Age as Decline								
Physical							.340***	.339***
Impairment							(12.158)	(12.121)
# of Life							.070***	.070***
Risky Dis.							(7.666)	(7.643)

Interaction-Term								
Education x Female								-.004 (-.866)
Education x Mainlander								.005 (.665)
R^2	.014	.037	.058	.069	.135	.151	.240	.241

Notes: Unstandardized coefficients with t-statistics in parentheses shown.
a. The intercept represents the predicted depression score at the initial age, 50, for the average respondent. Initial age and Age presents rising aging curve while Age^2 displays falling age curve. Aging components are measured as a deviation from the initial age.
b. Education years is modeled as (Education – the sample mean of education) x 10^{-1}.
c. Respondents whose highest-educated child's education is equal or above 13 years is coded as 1. Compared to those whose highest-educated child's education is less than 13 years. Respondents without children are included for statistical adjustment.
d. Compared to respondents who are equal or above middle third of the income level.
e. Compared to respondents who are currently employed.
f. Compared to respondents who did not report dissatisfying with his or her received social support.
g. Compared to respondents who did not live with their children or didn't contact their children daily.
$^{+}$ p < .10; * p < .05; ** p < .01; *** p < .001.

changes the trajectories with the adjustment of education (Model 3), as indicated in Figure 4.3.

4) Maturity Components

Although there is no direct measure of maturity, it is sensible that more mature people are more likely to maintain stable interpersonal relationships and avoid negative interactions. The adjustment of social relationships partially eliminates the falling trajectories in depression and reflects the indirect effects of maturity. In the 2005 TSCS sample, 22% (100 x [-.691-(-.541)]/-.691, from Model 5 to Model 6 of the coefficient of *Age* in Table 4.2) of the falling curve is reduced after the adjustment.

Meanwhile, the residual decline in depression, after adjusting for differences in economic, social and functional statuses, shows the force of maturity. In the 1996 middle-aged sample and the 1989 elderly sample, predicted depression diminishes in successively older age groups, after adjusting for economic, social, and functional statuses, as indicated in Figure 4.4 (Model 7 in both graphs). The patterns suggest that,

Table 4.4: Progressive Adjustment: Depression (Square-Root) Regressed on Aging Components and Variables Representing Aging Views: Taiwan, the 1989 Elderly Baseline Sample (N = 3,896)

Variables	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8
Initial D. [a]	.411***	.418***	.430***	.438***	.446***	.445***	.463***	.463***
Age (10^{-2})	.543***	.456***	.302**	.207*	.099	.113	-.118	-.123
	(4.838)	(4.094)	(2.685)	(1.849)	(.850)	(.993)	(-1.051)	(-1.093)
Age as Survival								
Female		.157**	.116***	.117***	.096***	.095***	.074***	.074***
(=1)		(10.761)	(7.471)	(7.530)	(5.582)	(5.613)	(4.565)	(4.404)
Mainlander		.030+	.072***	.043*	.042*	.016	.010	.013
(=1)		(1.728)	(3.997)	(2.368)	(2.427)	(.887)	(.603)	(.712)
Age as Cohort								
Education [b]			-.141***	-.092***	-.040*	-.030	-.024	-.013
			(-7.718)	(-4.705)	(-2.142)	(-1.606)	(-1.324)	(-.509)
H-Educated				-.070***	-.023	-.011	-.007	-.007
Child [c]				(-4.459)	(-1.486)	(-.703)	(-.501)	(-.515)
No Child [c]				.104*	.085+	.044	.036	.034
				(2.132)	(1.839)	(.950)	(.809)	(.766)
Non-Investor				.137***	.067***	.051**	.039*	.036*
(=1)				(7.528)	(3.799)	(2.949)	(2.322)	(2.172)
Age as Life Stage								
Economic					.196***	.170***	.144***	.144***
Hardship					(19.931)	(17.100)	(14.900)	(14.925)
Lowest 3rd					-.023	-.031*	-.037*	-.036*
Income [d]					(-1.445)	(-1.976)	(-2.445)	(-2.371)
Missing					-.045	-.056	-.086+	-.086+
Income [d]					(-0.820)	(-1.054)	(-1.670)	(-1.675)
Out of Labor					.093***	.090***	.048**	.048**
Force [e]					(5.873)	(5.782)	(3.174)	(3.176)
Never Work [e]					.056*	.049*	.014	.013
					(2.277)	(2.012)	(.582)	(.572)
Widowed					.060*›	.046**	.049**	.050***
(=1)					(3.628)	(2.814)	(3.121)	(3.181)
Age as Maturity								
Support						-.150***	-.144***	-.144***
						(-8.949)	(-8.964)	(-8.961)
Relationship						.030+	.030+	.029+
Dissatisfy [f]						(1.814)	(1.860)	(1.840)
Child						-.028+	-.029+	-.030+
Contact [g]						(-1.700)	(-1.860)	(-1.921)
Age as Decline								
Physical							.164***	.165***
Impairment							(11.464)	(11.447)
# of Life							.070***	.070***
Risky Dis.							(11.440)	(11.411)

Interaction-Term								
Education x								-.002
Female								(-.487)
Education x								-.001
Mainlander								(-.396)
R^2	.006	.035	.050	.072	.170	.197	.262	.262

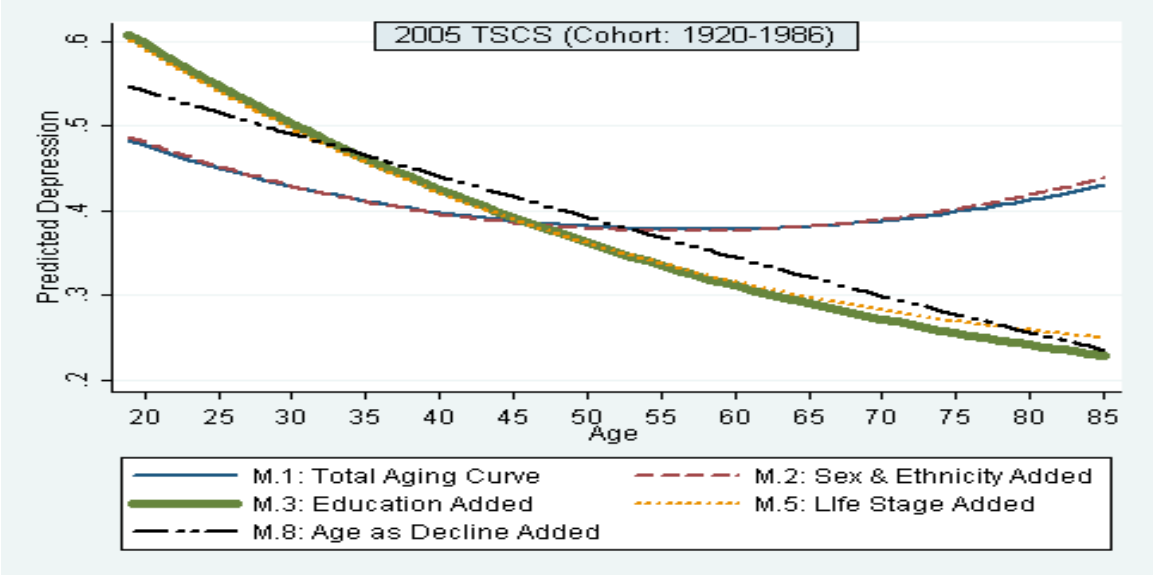
Notes: Unstandardized coefficients with t-statistics in parentheses shown.
a. The intercept represents the predicted depression score at the initial age, 60, for the average respondent. Initial age and Age^2 presents rising aging curve. Aging components are measured as a deviation from the initial age.
b. Education years is modeled as (Education – the sample mean of education) x 10^{-1}.
c. Respondents whose highest-educated child's education is equal or above 13 years is coded as 1. Compared to those whose highest-educated child's education is less than 13 years. Respondents without children are included due to statistical control.
d. Compared to respondents who are equal or above middle third of the income level.
e. Compared to respondents who are currently employed.
f. Compared to respondents who did not report dissatisfying with his or her received social support.
g. Compared to respondents who did not live with their children or didn't contact their children daily.
$^{+}$ p < .10; * p < .05; ** p < .01; *** p < .001.

were it not for differences in these statuses, average levels of depression would decrease throughout the life course, as expected in the "age as maturity" hypothesis.

5) Decline Components

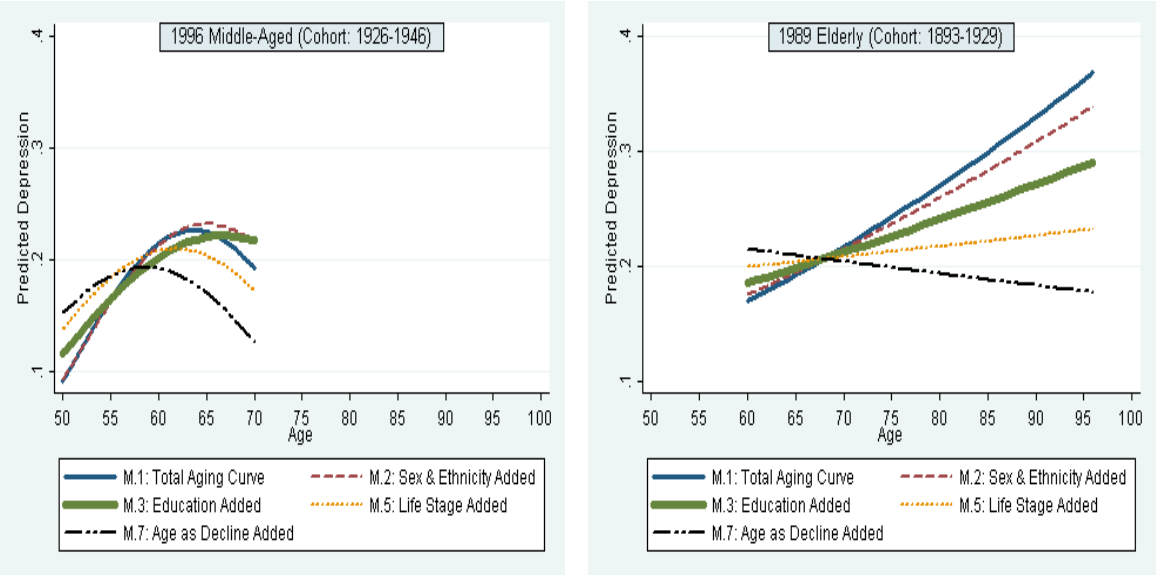
Old age brings physical dysfunction and powerlessness, both of which contribute to the rising curve in depression. Comparisons of curves 5 and 7 in Figure 4.4 (both graphs) show that age-group differences in physical impairment and life-threatening diseases account for rising depression in late adulthood. Adding the adjustment of physical impairment and life-threatening diseases drops the predicted depression for older adults noticeably. The patterns are much smaller in the 2005 TSCS sample. Nonetheless, the measures of physical impairment and chronic diseases are relatively unspecific in the 2005 TSCS data. The influence of physical health may be underestimated.

Figure 4.3: Progressive Adjustment of Predicted Depression (Square of the Predicted Value in Models) Over the Life Course: Taiwan, TSCS 2005.



Note: Equation numbers correspond to regression columns in Table 4.2.

Figure 4.4: Progressive Adjustment of Predicted Depression by Age: Taiwan, the 1989 Elderly Baseline Sample and the 1996 Middle-Aged Baseline Sample.



Note: Equation numbers correspond to regression columns in Table 4.3 and 4.4 for the 1996 middle-aged sample and the 1989 elderly sample, respectively.

6) Supplemental Analyses

Demographic, educational, economic, social, and functional factors not only shape the aging trajectories in depression but also influence depression, as indicated in Table 4.2, Table 4.3, and Table 4.4. Among these factors, being female, education, economic hardship, out of labor force in late life, loss of spouse, support in late life, negative interactions, physical dysfunction, and life-threatening diseases all display strong and consistent impacts on depression in all three samples. Their effects will be further examined and discussed in later chapters.

Additionally, descriptive statistics presented in Chapter 3 suggest the manifest inequality in educational distribution between females and males and between Taiwanese and Mainlanders among the elderly population in Taiwan. This research hence further examines whether the effects of education on depression are contingent on sex or ethnicity. The nonsignificant interaction terms between education and sex and between education and ethnicity in the 1996 middle-aged sample and in the 1989 elderly sample indicate that the effects of education on psychological well-being do not vary significantly between sex and between ethnic groups.

4. SUMMARY

This chapter denotes the cross-sectional aging trajectory in depression and fathoms whether age differences in depression are explained by risk factors associated with the five aging views in Taiwan. In terms of the aging trajectories, the present results from six cross-sectional samples demonstrate the parabolic patterns of depression declining and then rising in successive Taiwanese age groups. That is, depression is lowest among the middle aged, higher among younger and older adults, and highest

among the oldest. Nonetheless, predicted depression declines after around age 85 in the pooled TSCS samples over the full adult age range from 19 to 97. This result may be artifactual due to selective mortality for at least two reasons. First, the respondents over age 85 are probably survivors with extremely lower levels of depression since they account for less than 1% of each sample. Second, depression increases with age noticeably in the 1989 survey of the elderly, which is the sample without truncating the oldest age groups. As a result, attrition of the most depressed individuals—usually through death—may attenuate the obvious upsurge of depression in late life in the cross-sectional analyses.

Among five aging views, "age as historical trends" hypothesis receives remarkable support. The effects are statistically greater than those found in previous U.S. studies (Mirowsky and Ross 1992; Yang 2007). As an indicator of historical progress, education accounts for 32% to 44% of the rising depression in late adulthood in the three examined samples. It reflects greater differences in life conditions across generations and suggests the importance of considering cohort effects in Taiwan. "Age as life stage" statuses such as economic hardship in late life, retirement, and widowhood, and "age as decline" risk factors such as physical dysfunction and life-threatening diseases noticeably explain the rise in depression in successive age groups, but their effects are partially cancelled by the emotional assets of "maturity" by age. Nevertheless, although sex partially explains the rising curve in late life, the overall test only slightly supports the view of "age as differential survival."

Taken together, the results discovered in this chapter demonstrate the significant effects of education on shaping aging trajectories and echo the importance of considering cohort effects and selective mortality in the study focusing on the Taiwanese society. As a consequence, the following chapter utilizes the standard age-cohort regression model on

the pooled TSCS data and the aging vector model on the middle-aged and elderly panel samples to study the temporal relationships between education and depression with distinguishing aging effects and cohorts effects. The influence of selective mortality is also further examined in the aging vector model with FIML estimation.

Chapter 5: Life-Course Patterns and Cohort Patterns between Education and Depression in Taiwan: The Integrative Appraoch

1. HYPOTHESES

Making the unbiased estimation of the aging trajectories in depression without considering cohort effects and selective mortality is difficult in Taiwan, which is a setting that has undergone tremendous social change. This chapter hence adopts an innovative approach to integrate the life-course and cohort perspectives and to delineate the temporal relationships between education and depression in Taiwan. Utilizing the standard age-cohort regression model (Lynch 2003) on the pooled repeated cross-sectional data from the 1990, 1995, 2000, and 2005 TSCS and the aging vector model (Mirowsky and Kim 2007) on data drawn from the longitudinal 1989, 1993, 1996, 1999, and 2003 *Survey of Health and Living Status of the Middle-Aged and Elderly in Taiwan*, this research disentangles the confounding effects of aging process and cohort variations. In particular, the age-cohort regression model provides an opportunity to observe whether the location of the age-education patterns differs across cohorts, while the aging vector model enables this study to investigate whether the origins and slopes of change of depression vary across levels of education and even to reveal inter-cohort trends. On the foundation of the preceding discussion in previous chapters, the following hypotheses are established.

1) The Temporal Relationships between Education and Depression

This chapter assesses a specific Taiwanese phenomenon: "reversed aging trajectories" hypothesis, which predicts that the aging trajectories in depression differ across levels of education. The trajectories benefit the less-educated in early adulthood

but the patterns are reversed after middle age, which reinforces educational-based divergence in depression.

Subsequently, this study extends the discussion of three temporal patterns between education and depression to Taiwan—the inconsistent findings among them lead to one of the most important debates in the Western paradigm, including:

The "Cumulative advantage" hypothesis: the effects of education strengthen across the life course and lead to a diverging educational-based differential in depression.

"Age-as-lever" hypothesis: disparity in depression across levels of education after middle age will start converging, especially when selective mortality is completely ignored.

"The Rising importance" hypothesis: the effects of education increase across birth cohorts and then make the greater rate of educational-based divergence in depression for younger cohorts.

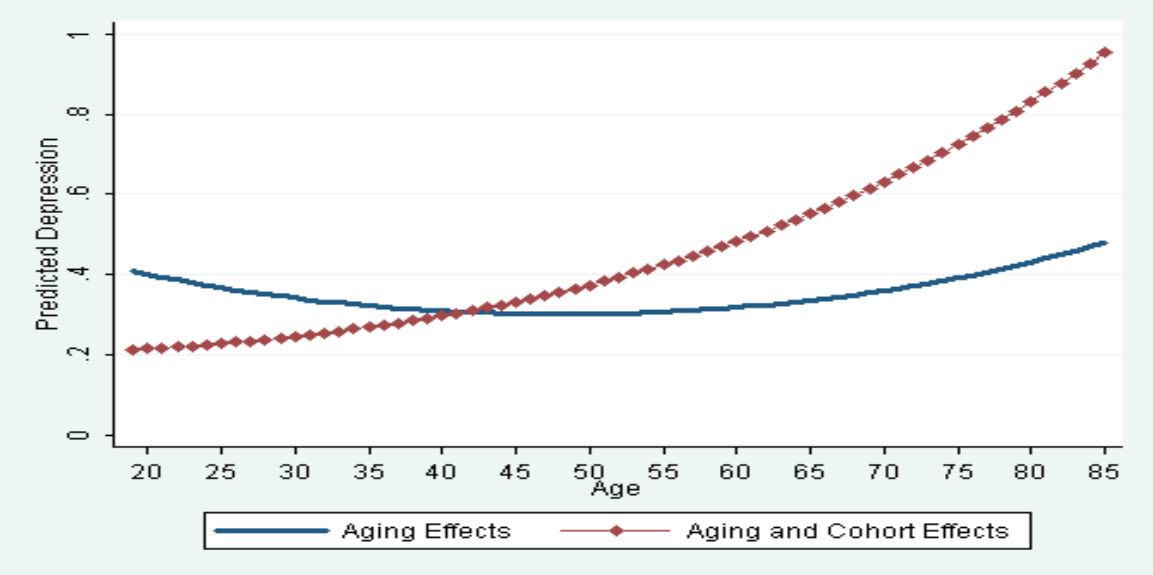
2) The Influence of Mortality Selection

The last set of analyses of this chapter investigates the potential selective mortality bias and searches the empirical evidence of depression-mortality patterns in Taiwan. Two supplemental hypotheses are formulated.

"Outcome underestimation" hypothesis: the age pattern in the education-depression relationship will be attenuated if unobserved depression for decedents are totally ignored.

"Selective mortality" hypothesis: the more depressed and the less educated have higher risks of dying during the observation time.

Figure 5.1: Predicted Depression (Square of the Predicted Value in Models): The Comparison Between Results Without and With Considering Cohort Effects (Cohort Fixed at 1955), Adjusting For Sex and Ethnicity (Fixed at Mean).



2. AGING TRAJECTORIES AND COHORTS VARIATIONS

Does the projected U-shape life course trajectory in depression vary after taking cohort effects into consideration in Taiwan? Consistent findings are discovered with the use of two distinctive approaches. Table 5.1 presents the results of the age-cohort model of the pooled TSCS data. The first model focuses on aging effects and demonstrates the expected U-shape aging trajectories in depression. Nonetheless, when aging effects and cohort effects are considered concurrently in Model 2, the results differ noticeably from those predicted in Model 1 in which aging effects are estimated independently. It indicates that the age pattern in the education-health relationship will be attenuated if the cohort pattern is totally ignored. As illustrated in Figure 5.1, the U-shape age-depression patterns disappear. That is, depression is lowest in early adulthood, increases slowly in middle age, and subsequently rises steeply in late life among the Taiwanese population.

Table 5.1: Depression (Square-Root) Regressed on Age, Cohort, Education, and Their Interactions, Adjusting for Sex and Ethnicity: Taiwan, TSCS 1990, 1995, 2000, and 2005 (N = 8,602).

Variables	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7
Intercept	.521***	.545***	.549***	.546***	.544***	.551***	.554***
Age (10^{-2})	-.068*	.663***	.644***	.567***	.584***	.594***	.576***
	(-2.109)	(7.957)	(7.735)	(6.632)	(6.951)	(6.926)	(5.545)
Age^2 (10^{-2})	.011***	.008***	.008***	-.001	.003	-.001	-.019**
	(5.437)	(4.303)	(3.942)	(-.379)	(1.225)	(-.567)	(-2.658)
Cohort (10^{-2})		.779***	.904***	.825***	.834***	.859***	.924***
		(9.513)	(10.728)	(9.725)	(9.752)	(10.059)	(9.078)
Age x Cohort (10^{-3})							-.203**
							(-2.763)
Educ. (10^{-2})			-.787***	-.641***	-.561***	-.898***	-1.000***
			(-6.077)	(-4.213)	(-4.071)	(-5.267)	(-5.780)
Age x Educ. (10^{-3})				-.587***		-1.187***	-1.379***
				(-6.423)		(-5.880)	(-6.214)
Age^2 x Educ. (10^{-3})				.001		.004	.034**
				(.158)		(.810)	(2.601)
Cohort x Educ. (10^{-3})					.388***	-.622**	-.996***
					(4.766)	(-3.331)	(-4.459)
Age x Cohort x Educ.(10^{-3})							.036**
							(2.669)
Female (=1)	.066***	.067***	.055***	.051***	.053***	.050***	.052***
	(7.086)	(7.232)	(5.826)	(5.435)	(5.650)	(5.342)	(5.521)
Mainlander (=1)	-.024$^+$	-.017	.005	.008	.007	.009	.004
	(-1.710)	(-1.239)	(.367)	(.589)	(.501)	(.598)	(.287)
R^2	.010	.020	.024	.030	.027	.031	.033

Note: Unstandardized coefficients with t-statistics in parentheses shown. Aging components are centered as 45, birth cohort is centered as 1955, and education is centered as its mean, 10.
$^+$ p < .10; * p < .05; ** p < .01; *** p < .001.

Additionally, the trajectory with the adjustment of cohort effects rises more tremendously in late life than the original trajectory, which suggests that older cohorts have lower levels of depression in Taiwan.

The aging vector estimates based on the panel samples of the Taiwanese middle aged and elderly across five waves and 14 years are consistent with the hypothesized life course trajectory of depression, with increases in late adulthood, as indicated in Table 5.2 (all of them fit the observed data well with the comparative fit indexes (CFI) over .995 and the root mean square of the analysis below .015). Model 2 is the prototype that

Table 5.2: Level and Slope in Depression Regressed on Age, Education, and Their Interaction Terms, Adjusting for Sex, Ethnicity, and Physical Health Measures, based on a Multi-Indicator Structural Equation Model With Time Centered on Mid-Follow-Up.

	Total Sample with FIML Estimation [a]							Cases [b] in
Variables	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	All Waves
LEVEL								
(Age-70) x 10^{-2}	.857***	.897***	.765***	.754***	.763***	.482***	.280***	.543***
	(9.779)	(17.745)	(15.442)	(13.194)	(14.891)	(10.358)	(5.457)	(6.004)
(Age-70) ^{2} x 10^{-2}	-.007$^+$	-.008*	-.006	-.005	-.004	-.008*	-.014***	-.013*
	(-1.948)	(-2.193)	(-1.619)	(-1.131)	(-1.082)	(-2.128)	(-3.984)	(-1.966)
(Age-70) ^{3} x 10^{-4}	.020							
	(.749)							
(Educ.-6) x 10^{-2}			-1.417***	-1.684***	-1.672***	-1.388***	-1.360***	
			(-11.749)	(-11.424)	(-11.389)	(-10.428)	(-10.348)	
Education x Age [c]				-.004				
				(-.390)				
Education x Age^2 [c]				.001	.001$^+$	.001$^+$	.001$^+$	
				(1.606)	(1.745)	(1.665)	(1.821)	
Phys. Impairment						.296***	.279***	
						(29.624)	(28.604)	
# of Life-Risky						.071***	.067***	
Diseases						(16.186)	(15.483)	
Death [d]							.134***	
							(12.849)	
Female (=1)	.155***	.155***	.116***	.115***	.115***	.084***	.092***	.169***
	(15.405)	(15.368)	(11.419)	(11.377)	(11.381)	(9.266)	(10.187)	(14.882)
Mainlander (=1)	-.021$^+$	-.021$^+$	.024$^+$	.033	.033*	.023*	.028*	-.011
	(-1.696)	(-1.726)	(1.873)	(2.574)	(2.532)	(1.956)	(2.396)	(-.681)
Intercept	.322***	.322***	.310***	.306***	.306***	.225***	.205***	.254***
	(37.273)	(37.497)	(35.490)	(34.579)	(34.645)	(24.531)	(20.627)	(23.647)
Residual Variance	.073***	.073***	.072***	.072***	.072***	.056***	.055***	.056***
	(21.531)	(21.436)	(22.282)	(22.422)	(22.400)	(23.760)	(23.921)	(17.940)
R^2	.169	.166	.203	.208	.207	.488	.521	.157
SLOPE								
(Age-70) x 10^{-2}	.051***	.053***	.055***	.044***	.045**	.051***	.025$^+$	.021
	(4.198)	(4.402)	(4.422)	(3.410)	(3.468)	(3.947)	(1.859)	(1.144)
(Age-70) ^{2} x 10^{-2}	.002***	.002**	.002***	.001*	.001*	.002***	.001	.000
	(3.500)	(3.138)	(3.389)	(2.402)	(2.397)	(3.653)	(1.450)	(.208)
(Age-70) ^{3} x 10^{-4}	-.006	-.008$^+$	-.009*	-.009*	-.010*	-.009*	-.009*	-.002
	(-1.590)	(-1.949)	(-2.273)	(-2.085)	(-2.395)	(-2.154)	(-2.234)	(-.200)
(Educ.-6) x 10^{-2}			-.034*	-.065***	-.058***	-.061***	-.061***	
			(-2.013)	(-3.398)	(-3.893)	(-4.113)	(-4.155)	
Education x Age [c]				-.004**	-.005**	-.004**	-.004**	
				(-2.862)	(-3.044)	(-2.963)	(-2.899)	
Education x Age^2 [c]				.000				
				(.539)				

Phys. Impairment						.007***	.006***	
						(5.329)	(4.057)	
# of Life-Risky Diseases						-.001	-.001*	
						(-1.631)	(-2.099)	
Death [d]							.020***	
							(12.238)	
Female (=1)	.003**	.003**	.002					.002
	(2.602)	(2.605)	(1.504)					(1.101)
Mainlander (=1)	-.004*	-.004*	-.003					-.004+
	(-2.183)	(-2.215)	(-1.596)					(-1.885)
Intercept	.004***	.005***	.004***	.004***	.005***	.005***	.003**	.006***
	(3.555)	(3.655)	(3.504)	(4.269)	(4.371)	(4.386)	(2.805)	(3.463)
Residual Variance	.001***	.001***	.001***	.001***	.001***	.001***	.001***	.000***
	(8.085)	(8.078)	(8.219)	(8.234)	(8.237)	(8.734)	(8.550)	(6.699)
R^2	.041	.038	.042	.045	.044	.097	.216	.012
Residual Covariance	.001***	.001***	.001***	.001***	.001***	.001***	.001***	.001***
FIT STATISTICS								
χ^2	134.411	134.706	152.739	176.670	177.177	249.572	248.133	110.819
df	59	60	68	86	88	104	112	70
CFI	.997	.997	.997	.997	.997	.996	.996	.998
NFI	.994	.994	.994	.995	.995	.993	.994	.994
RMSEA	.014	.014	.014	.013	.012	.015	.014	.013

Note: Metric coefficients with Critical-ratio in parentheses.

a. The total sample size is 6,511. Full Information maximum-likelihood is used to correct for attrition (assuming MAR).

b. 3,372 respondents appear in all waves. Correlation of measurement errors of malaise indicators across waves is not allowed in this model.

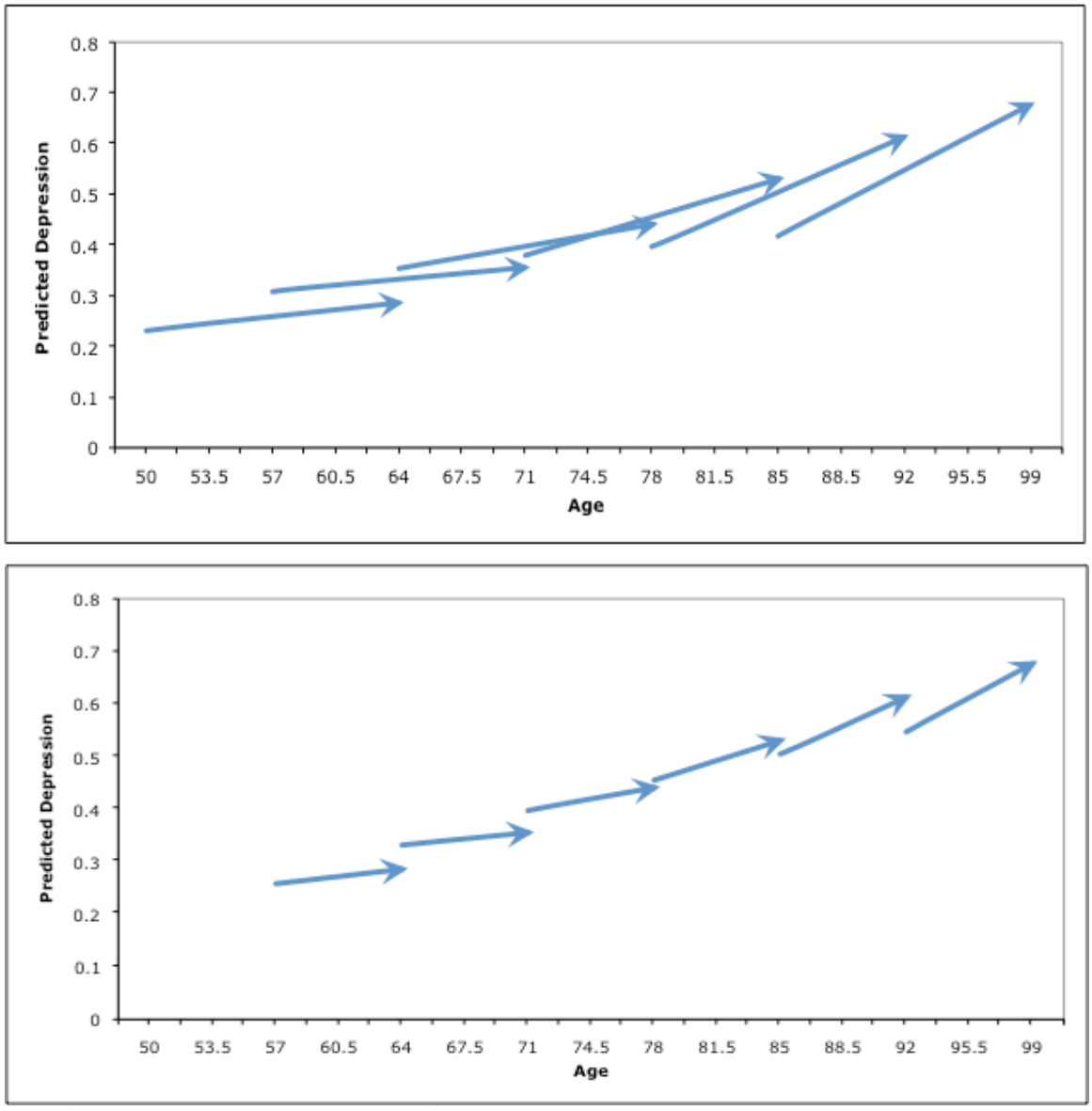
c. Education x Age is modeled as (Education-6) x (Age-70) x 10^{-2}. Education x Age^2 is modeled as (Education-6) x (Age-70)^2 x 10^{-2}.

d. Compared to respondents who are not dropouts due to death.

+$p < .10$; ** $p < .05$; ** $p < .01$; *** $p < .001$.

confirms the expected quadratic effects of age on the within-person level, which represents the expected depression at midpoint of the follow-up period, and generally supports the expected positive effects of age on the within-person slope. The significant and positive coefficients of the age functions indicate that the predicted level and change of depression increase as age at baseline increases, while the significant and negative coefficients of the age functions represent the falling curve occurring in old ages, which partially offsets the rising depression. As usual with growth curve, the overall aging trajectories are not immediately evident because trajectories consist of two sets of

Figure 5.2: Vector Graphs of Predicted Level and Slope of Depression for Every Seventh One-Year Cohort.



Note: Corresponding to Model 2 in Table 5.2.
In the top panel, these selected vectors (from left to right) represent respondents born in 1939, 1932, 1925, 1918, 1911, and 1904. Each selected vector begins at the predicted level of depression at the middle follow-up wave (when they at age 57, 64, 71, 78, 85, and 92 in 1996) and represent the predicted annual change (slope) multiplied by 7 for the vector arrowhead (the predicted depression at the final wave) and by -7 for the vector end (the predicted depression at the first wave). In the bottom panel, only the final 7-years out of the original 14-year aging vectors remain in order to emphasize disjunction across vectors.

equations in predicted constant and change, both of which are simultaneously influenced by multiple forms of age functions. The aging vector graph is designed to solve the complexity and capture the composite trajectory.

Figure 5.2 illustrates the vectors implied by results of Model 2 in Table 5.2 and reveals two phenomena: To begin with, depression changes within birth cohorts as individuals aged 14 years, although the slope seems to be steeper in the successively age groups. In Figure 5.2, each vector represents the predicted level and slope in depression for 1-year birth cohorts. The horizontal axis identifies the cohort's age at the beginning and end of the period. The vertical axis demonstrates its predicted depression at the beginning and end. Only the vectors for every seventh aging group are shown in order to simplify the figure. For instance, the first vector (the vector starts at age 50 and ends at age 64) in the top panel of Figure 5.2 represents individuals 57 years old in 1996. Since time is centered on the midpoint of the follow-up periods, the predicted constant of depression means the predicted level of depression on the middle point and is calculated by substituting 57 for A_{i0} in the level equation, multiplying by respective coefficients, and summing the products of control variables such as female and Mainlander. Average annual change in depression is calculated in a similar manner using the slope equation, and multiplying by t years (7 in this example), and then subtracting and adding that 7-year change in depression (presents aging by 7 years) to the midpoint depression to get the predicted depression at the beginning and end, respectively. The same approach is used for ages 64, 71, 78, 85, and 92 in 1996. Accordingly, these six vectors suggest that depression remains relatively stable for individuals transiting middle age, rises for individuals becoming old, and surges dramatically for the oldest-old. The trajectory is consistent with the life trajectory suggested by the cross-sectional TSCS findings.

Subsequently, Figure 5.2 shows the changes in age-specific depression between cohorts—so-called inter-cohort trends—reaching the same age 7 years apart. The selected vectors in Figure 5.2 (from left to right) represent the 1939, 1932, 1925, 1918, 1911 and 1904 birth cohorts, as computed using Equation (11) in Chapter 3. For this 14-year period between 1989 and 2003, the vertical displacement between adjoining vectors manifests a favorable trend toward lower levels of depression across cohorts in middle-aged groups but an unfavorable trend across cohorts after age 70. The seven-year vectors are derived from the original 14-year vectors to display clear disjunction across cohorts in the bottom panel in Figure 5.2. For instance, the predicted depression at age 64 is somewhat lower for individuals who were born in 1939 (those aged 57 in 1996) than for those who were born in 1932 (those aged 64 in 1996). However, the predicted depression at age 85 is somewhat higher for individuals who were born in 1918 (those aged 78 in 1996) than for those who were born in 1911 (those aged 85 in 1996). The switch from favorable to unfavorable trends occurs around the 1932 birth cohort.

Taken as a whole, this section confirms that depression increases in late life with taking cohort effects into consideration. However, cohort variations in depression are uncertain. Although the TSCS results imply that depression levels are generally higher among younger cohorts in Taiwan, the aging vector results indicate the discontinuous patterns. That is, depression levels increase with more recent cohorts among those born before 1930, but depression levels are lower among 1930-1946 cohorts than their previous counterparts. The possible reason is that these Taiwanese born before 1930 had experienced World War Two and post-war times with political regimes transition. They hence have more depression levels afterwards. Conversely, people born between 1930 and 1946 were teenagers or even little children during this particular period. It was relatively easier for them to adjust to new environments. As a result, people born before

and after 1930 should be regarded as two subpopulations in terms of historical experiences. Unfortunately, the middle-aged and elderly panel samples lack information for individuals born after 1946, it is hence difficult to judge whether depression increases with more recent cohorts again after the 1946 birth cohorts.

3. FOUR TEMPORAL PATTERNS BETWEEN EDUCATION AND DEPRESSION

Does education predict depression in Taiwan? Furthermore, do the life course trajectories and cohort variations in depression differ by levels of education? Both answers are affirmative. Table 5.1 and Table 5.2 consistently demonstrate that education is inversely associated with depression, as indicated by the significant and negative coefficients of education in all models, after adjusting for demographic variables (female, physical impairment, and life-threatening diseases are also consistently associated with higher levels of depression, while the effects of being a Mainlander are nonsignificant and inconsistent). The results of aging vectors even suggest that the well-educated not only have lower initial levels of depression but also have lower rates of depression change over time. Moreover, after adding education and the multiple forms of interaction terms between age functions and education (and between cohort and education in the TSCS models) in the analyses, the coefficients of age functions (and cohort in the TSCS models) vary substantially, underscoring the importance of understanding dynamic processes of aging, cohort changes, and temporal educational effects in Taiwan. This section details the findings of four temporal patterns between education and depression.

1) Reversed Aging Trajectories, Cumulative Advantages, and Age-As-Lever

Table 5.1 and Table 5.2 progressively demonstrate that the models include various interaction terms between age and education and between age^2 and education. In the TSCS samples, ranging in ages from 19 to 85, the patterns are consistent with both cumulative advantage hypothesis and age-as-lever hypothesis. The effects of education strengthen across the life course to a point but eventually decline, as is evidenced by the significant negative coefficients of age-education interaction and the significant positive coefficients of age^2-education interaction (Model 4, Model6, and Model 7 in Table 5.1).

Meanwhile, the aging vector estimates of the middle aged and elderly samples provide substantial evidence for the cumulative advantage theory. The negative and significant coefficients of the age-education interaction with respect to the slope (Model 4 to Model 7 in Table 5.2) suggest that the effects of education on the change of depression increase in middle life and late adulthood, consistent with the core element of the theory: the cumulative effects of education decrease the magnitude of the rising depression as age increases. As a result, the insignificant coefficients of the age-education interaction on the constant of depression attenuate but do not seriously undermine the assumption of the cumulative advantage theory. Nonetheless, the overall patterns remain uncertain because the significant and positive coefficients of the age^2-education interaction suggest that the effects of education diminish in old ages and support the age-as-lever hypothesis.

The results of the age-cohort regression models and the aging vector models are best interpreted graphically. Figure 5.3 and Figure 5.4 show three things. First, as the reversed trajectories hypothesis expected, the direction and the magnitude of aging trajectory are contingent on education. As illustrated in Figure 5.3 (corresponding to Model 7 in Table 5.1, in which the three-way interaction among education, age, and

Figure 5.3: Predicted Depression (Square of the Predicted Value in Models) Across Life Course by Education, Adjusting for Cohort (Fixed at 1955), Sex, and Ethnicity (Fixed at Mean).

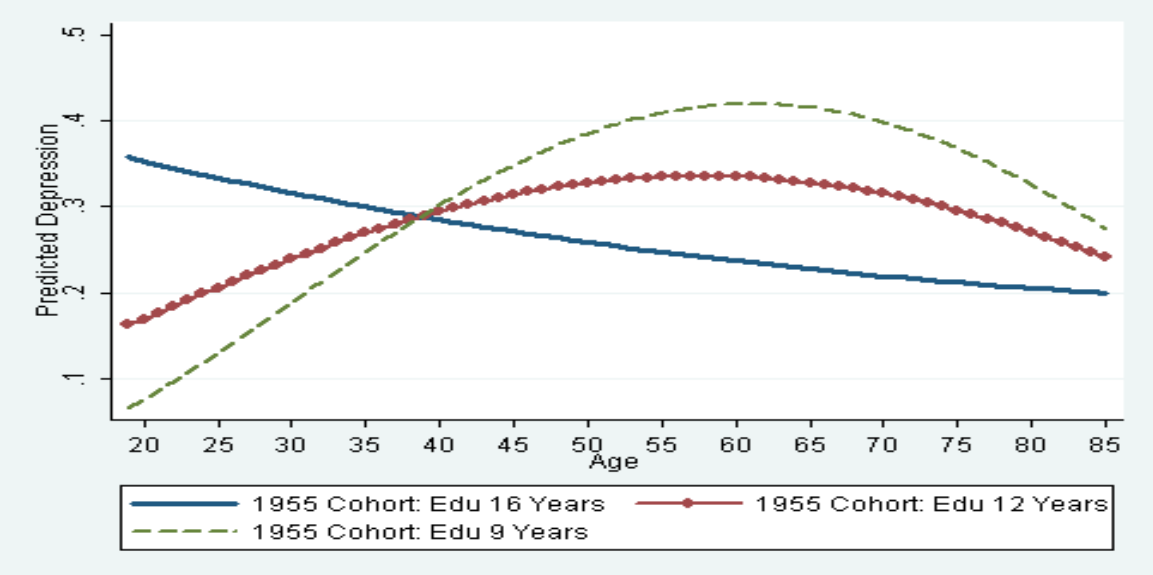
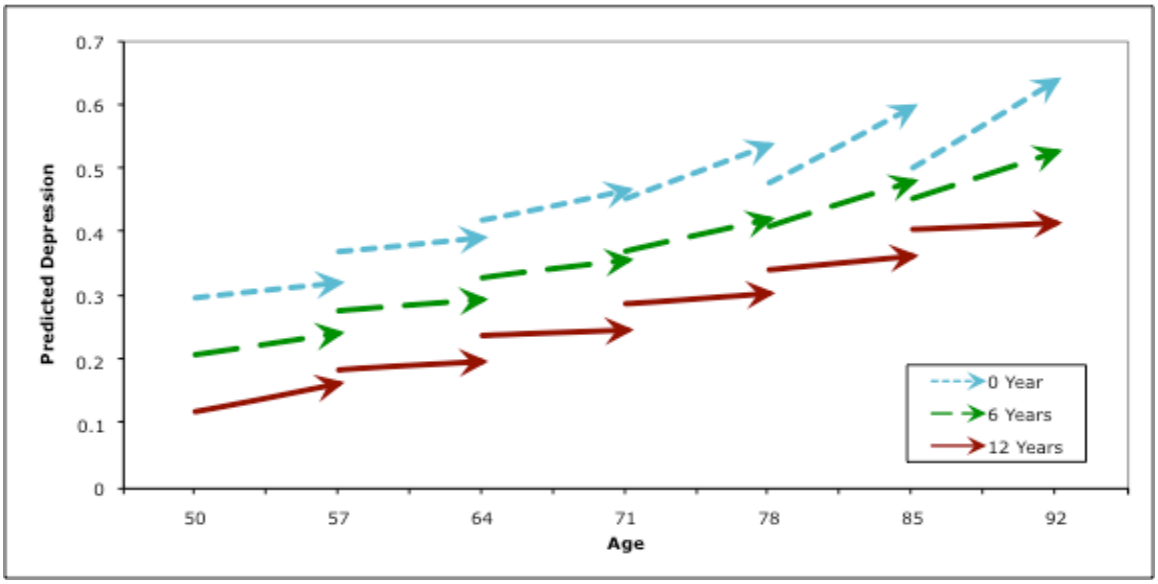


Figure 5.4: Simplified 7-Year Vector Graph of Predicted Level and Slope of Depression by Education Years.



Note: Corresponding to Model 5 in Table 5.2. In order to emphasize disjunction across models, the original 14-year aging vectors are simplified to 7-year vectors. These selected vectors (from left to right) represent respondents born in 1942-1943, 1935-1936, 1928-1929, 1921-1922, 1914-1915, and 1907-1908.

cohort is included), predicted depression[2] is higher in early adulthood and decreases at a relatively stable rate over their whole adulthood for the well-educated Taiwanese born in 1955 (the mean cohort of the samples). Conversely, predicted depression is lower in early adulthood but increases dramatically and is expected to peak at middle life, around age 60, and then declines at an accelerating rate for the low-educated Taiwanese born in 1955. Taken as a whole, the aging trajectory of the well-educated Taiwanese is the opposite to those of their low-educated counterparts. Although younger Taiwanese with higher levels of education are more depressed, the patterns are reversed around age 40 and lead to the widening educational-based disparity that favors the well-educated in middle life, consistent with the reversed trajectories hypothesis and the cumulative advantage hypothesis.

Second, Figure 5.4 illustrates that the educational-based gap in depression vectors of the Taiwanese middle aged and elderly diverges over 14 years (corresponding to Model 5 in Table 5.2). As expected, the direction and the magnitude of aging trajectory depend on education. Although the predicted origins of depression increase with age regardless of education, the slopes of depression change differ. Depression change generally remains stable for the well educated over late adulthood. In contrast, the slopes of depression increase steeply in old ages for the less educated. Taken together, educational-based gap in depression remains stable during middle adulthood and then displays divergence in later life, suggesting the cumulative advantage phenomenon.

Nonetheless, the third phenomenon revealed in these two graphs is the inconsistent late life trajectories in depression. In the cross-sectional TSCS samples, the

[2] It is possible that the well-educated young people are more likely to report mood questions and thus display higher average levels of depression. The supplemental analysis examines the malaise trajectories alone and finds similar patterns as the depression trajectories including mood questions. As a result, higher levels of depression of the young well educated are not attribute to the response-bias.

gap starts shrinking after middle life and converges noticeably after age 85, consistent with the age-as-lever hypothesis; while in the aging vectors graphs with FIML estimations, the educational-based disparity in depression becomes wider and wider in late life. The results in the TSCS samples are probably attributable to selective mortality, as suggested by previous empirical studies on self-reported health (Lynch 2003). Individuals with the steepest rising trajectories in depression are eliminated out of the population due to mortality. As a result, in the TSCS samples, the slope of the depression decline in late life is greater for the individuals with lower levels of education, even though the slope is really still increasing. Furthermore, both graphs reveal that depression is very stable for the well educated. Thus, the effects of education do not diminish in late life. Moreover, since aging vectors models with FIML estimating approach attenuate attrition biases (Mirowsky and Kim 2007), divergence in late life is more convincing.

2) The Rising Importance of Education

The rising importance of education's effects is supported by various empirical evidences. Figure 5.5 (corresponding to Model 7 in Table 5.1) displays three phenomena. First, depression levels are higher among younger cohorts than older cohorts, regardless of education. Second, the magnitude of difference among cohorts depends on education. Among individuals with lower levels of education, younger cohorts visually have much higher depression levels than their older cohorts counterparts. Conversely, predicted depression levels are only slightly higher for the younger cohorts with higher levels of education than their counterparts. Third, educational-based disparity in depression emerges at an earlier age. The point of the reversed trajectories appears as late as in the 20s for the 1970 birth cohort, while in the late 40s for the 1955 birth cohort.

Figure 5.5: Predicted Depression (Square of the Predicted Value in Models) Across the Life Course by Birth Cohorts.

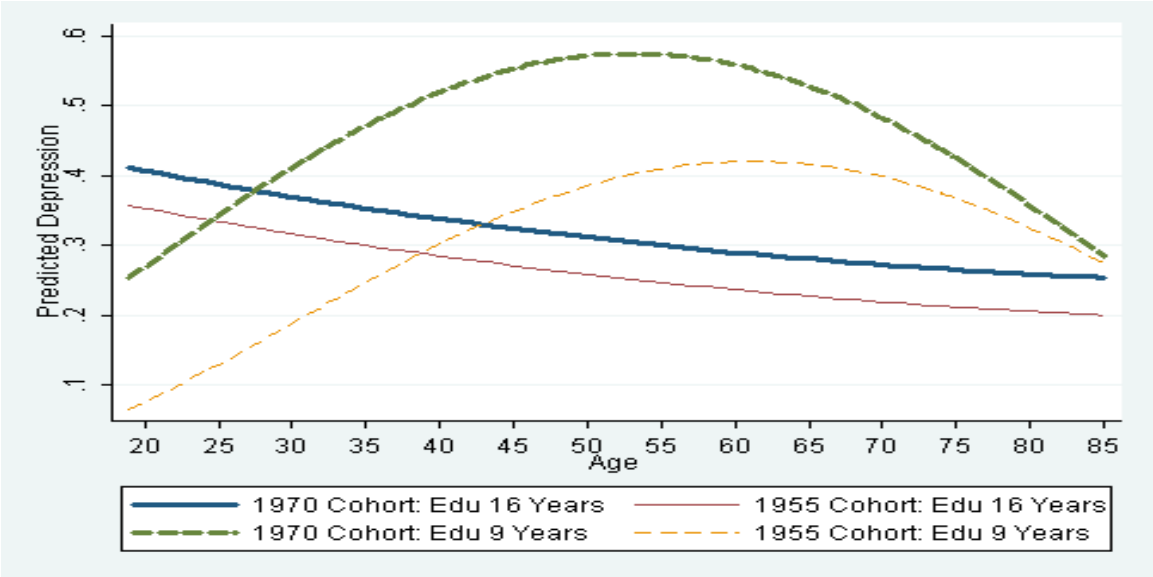
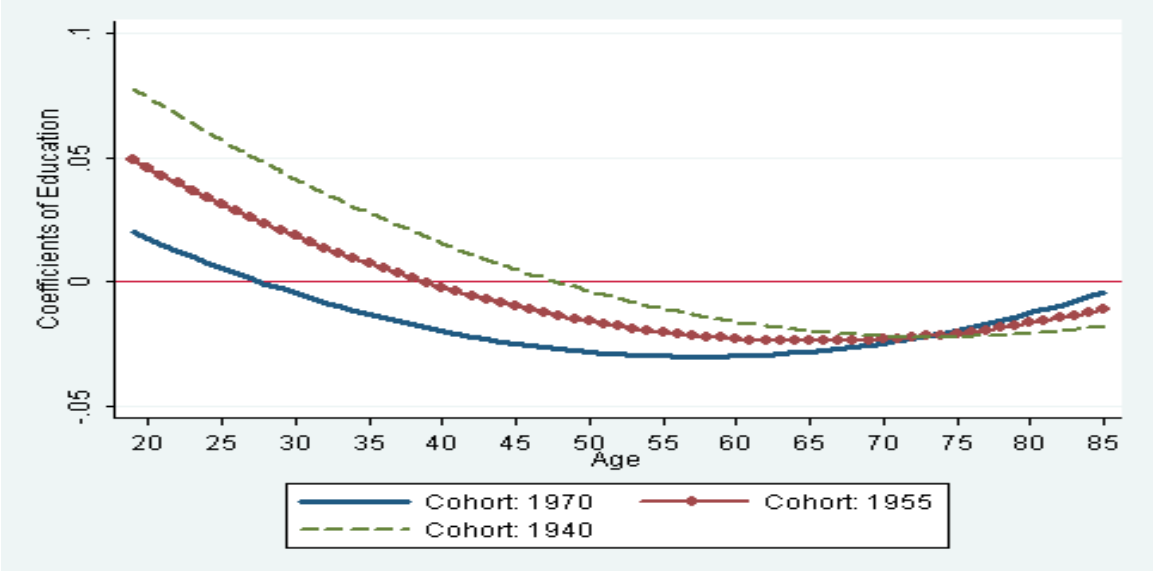


Figure 5.6: The Effects of Education on Depression Across the Life Course by Birth Cohorts.



Note: Right Graph Corresponds to Equation 6 in the method section.

Meanwhile, Figure 5.6 (corresponding to Model 7 in Table 5.1) illustrates the sum of educational effects (computed as the sum of coefficients contingent on education) by age for the selected 1940, 1955, and 1970 birth cohorts and indicates similar patterns. The magnitude of educational effects on depression, except those at very old ages, is stronger (greater negative coefficients) across birth cohorts, but the shape and the location of the quadratic life course patterns changes across cohorts. Among the 1970 birth cohort, the beneficial effects of education on depression start emerging as late as in the 20s (coefficients pass the coefficient line of 0 and become negative) and peaks at mid life, while the beneficial effects occur in the late 30s and late 40s for the 1955 and 1940 cohorts, respectively.

Additionally, Figure 5.4 reveals whether inter-cohort trends differ across levels of education among the Taiwanese elderly population. The consistent favorable trends happen for those with higher levels of education. For instance, among the individuals with 12 years of education, the predicted depression at age 78 is lower (the vector head is lower than its adjoining vector end) for the 1921-1922 birth cohort than the 1914-1915 birth cohort; while among the elderly with 0 years of education, the predicted depression at age 78 is much higher for the 1921-1922 birth cohort than the 1914-1915 birth cohort.

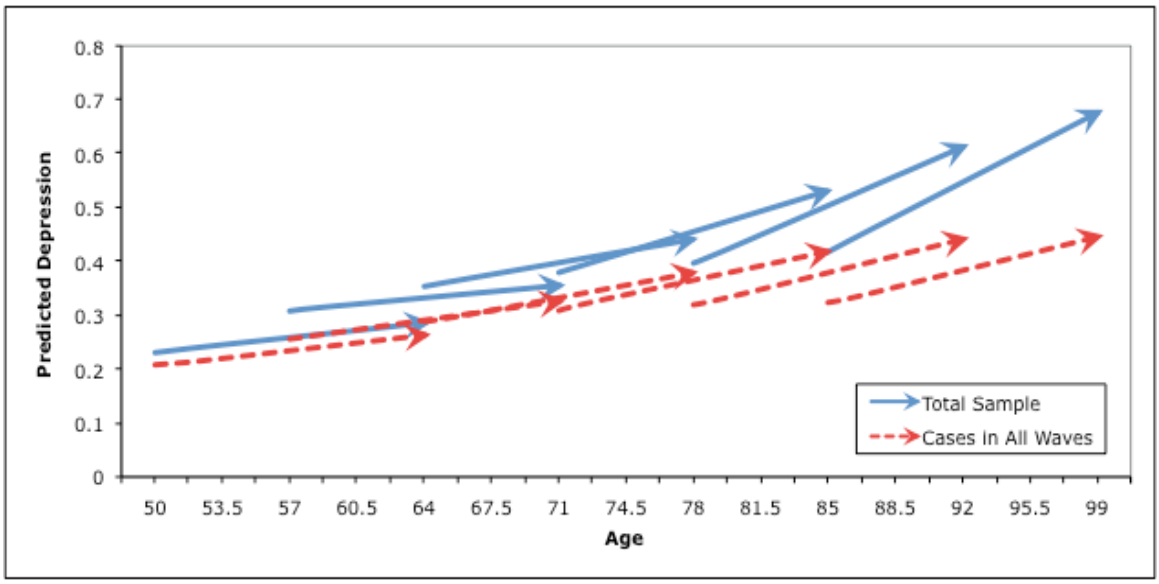
Taken together, although depression levels increase across younger birth cohorts in Taiwan, the effects of education on depression also strengthen across younger cohorts. In other words, as Taiwan transforms into a contemporary industrialized society, the importance of educational effects is growing. As a result, younger cohorts with lower levels of education probably face higher risks associated with higher levels of depression nowadays.

4. POSSIBILITY OF MORTALITY SELECTION BIAS

This section evaluates the potential selectivity mortality bias in this research. To begin with, Table 5.2 demonstrates the estimates of individuals who completed all valid interviews (the last column) to those for all respondents combined with FIML estimation (Model 2). The coefficients of aging functions on both depression constant and depression slope are much smaller and more likely to be nonsignificant for those who completed all valid interviews, underlining the importance of correcting for attrition. Figure 5.7 further compares the two sets of vectors. Dash vectors represent respondents who completed all interviews, while solid vectors are those for all respondents combined. The vectors remain similar in middle adulthood but become more different due to the growing difference in origins in late segments of late adulthood, which is when depression has its largest impact on attrition. As a result, when the estimations are only based on individuals who completed all surveys, the aging trajectory in depression is plausibly underestimated, especially in late ages.

Furthermore, this research examines whether survival status over the follow-up periods influences the estimations of educational-based divergence found in the elderly samples. Model 7 in Table 5.2 includes the dummy variable indicating dropouts due to death. Comparing with estimations in the previous models, controlling for attrition due to death only slightly affects the effects of education on depression constant and does not influence depression slope. The effects of education over the life course remain almost the same, regardless of follow-up status. As a consequence, the unobserved pattern of the decedents dropped out of surveys is possible to follow the patterns from their observed information and the imputation. Accordingly, mortality selection bias is less likely to affect the found patterns between education and depression in this research.

Figure 5.7: Aging Vectors of Predicted Level and Slope of Depression for Persons Interviewed in All Waves, Compared to the Vectors for the Total Sample.



Note: Corresponding to Model 2 and the model for respondents in all waves in Table 5.2. These selected vectors (from left to right) represent respondents born in 1939, 1932, 1925, 1918, 1911, and 1904.

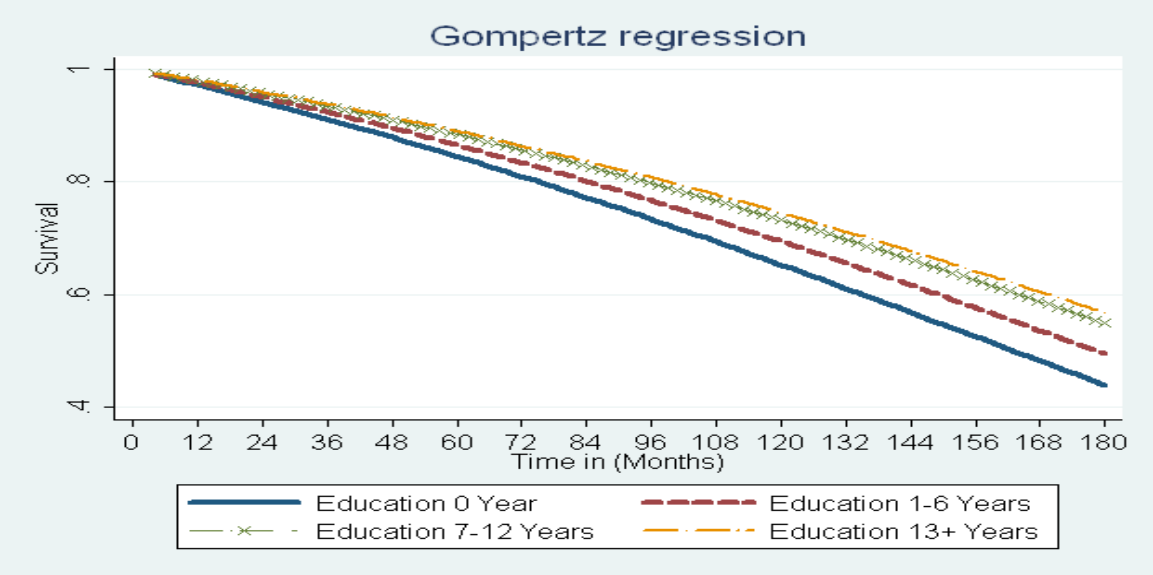
Additionally, this section uses Gompertz hazard analyses to examine the mortality patterns of the Taiwanese elderly over 14 years. As presented in Table 5.3, the results indicate that depression increases the risks of dying, although its effects are mainly due to physical impairment and chronic diseases. Meanwhile, education is inversely associated with risks of dying. For instance, Figure 5.8 shows that around 60% of the elderly who have over 13 education years still survived at the end of the last interview, while only around 45% of the individuals without education remained as survivors at the same time. The above phenomena suggest that the elderly Taiwanese population is full of overrepresented healthier and more educated individuals, providing indirect evidence that educational-based divergence in late life found in the TSCS samples is very likely due to mortality selection.

Table 5.3: Hazard Ratios of Dying Associated with the Gompertz Regression Models: Taiwan, the 1989-2003 Elderly Sample (N = 3,870).

Variables	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Depression in 1989	1.283***			1.288***	1.280***	1.031
Education		.960***		.976***		.978***
Educ. 1-6 Years [a]					.855**	
Educ. 7-12 Years [a]					.729***	
Educ. 13+ Years [a]					.689**	
Age			1.097***	1.094***	1.094***	1.088***
Female (=1)			.693***	.614***	.606***	.559***
Mainlander (=1)			.740***	.781***	.794***	.759***
Physical Impairment						1.601***
# of Chronic Diseases						1.235***
Gamma	.005***	.005***	.007***	.007***	.007***	.008***
-2LL	8586.7752	8562.7668	7844.3700	7786.4808	7782.8820	7547.6704

Note: a. Compared to respondents without education.
+$p < .10$; ** $p < .05$; ** $p < .01$; *** $p < .001$.

Figure 5.8: Survivals Across Time by Education Levels.



Note: Corresponding to Model 5 in Table 4.7.

5. SUMMARY

The core objective of this chapter is to elaborate life course and cohort patterns in the relationships between education and depression in Taiwan. This research finds one

specific pattern different from those in the Western societies. That is, the direction of aging trajectories differs across levels of education in Taiwan. The well educated are more depressed in early adulthood than their less-educated counterparts. The patterns are reversed and the educational-based disparity favoring the well educated starts emerging in mid life. This finding is consistent with the expected "reversed trajectories" hypothesis.

The life course patterns after middle adulthood are substantially similar to those in the Western context. To start with, the cumulative advantage hypothesis is validated. Disparity in depression across levels of education diverges across most of adulthood in the cross-sectional TSCS data and in the aging vector analyses. Taiwanese with higher education generally exhibit slower rate in deteriorating depression across age and even maintain stable status in depression until their late life. The well educated are more likely to repress their psychological distress within the last years of their life span. Meanwhile, the age-as-lever hypothesis is supported by the converging inequality in late life in the cross-sectional TSCS sample. However, the appearance of convergence may be attributed to mortality selection bias, as suggested by previous findings and indirectly demonstrated by the supplemental survival analyses. Last but not least, the rising importance hypothesis is strongly supported. Educational effects on depression strengthen across cohorts in the TSCS samples. It reflects that the effects of education are more important in modern capitalist societies characteristics of prevalent stressors, such as those resulting from competitive business environment or typical busy life style. The aging vector analyses also demonstrate a favorable trend toward lower depression for successive younger cohorts among people with higher education.

Chapter 6: Education, Economic Resources, Social Relationships, and Depression: Resource Substitution or Resource Multiplication

1. HYPOTHESES

Previous chapters have indicated that Taiwanese with higher levels of education are less depressed than their counterparts over the life course. This chapter further elaborates the mechanisms between education and psychological well-being. The research is this chapter takes the Taiwanese context into consideration and examines whether the strength of educational effects is essentially contingent on these mechanisms, by using OLS regression models on the 2005 TSCS sample and aging vector model on the data from the longitudinal 1989, 1993, 1996, 1999, and 2003 *Survey of Health and Living Status of the Middle-Aged and Elderly in Taiwan*.

First, this chapter investigates the relationships among education, economic resources, social relationships, and depression in Taiwan. Two hypotheses are formulated.

"Dominance and Protectiveness" hypothesis: Education is the overall root cause that shapes economic resources and social relationships that benefit psychological well-being. It also plays an influential role in the prevention of the progression of depression over time.

"Independence but Protectiveness" hypothesis: Education and social relationships are independent of each other in the collectivist society of Taiwan. However, education still exhibits crucial effects on the prevention of the progression of depression over time.

Subsequently, this chapter assesses the circumstances under which the effects of education on depression are greater by examining two competing hypotheses:

"Resource Substitution" hypothesis: The effects of education are stronger among individuals with "disadvantageous" statuses with respect to economic conditions or social relationships (the coefficients of interaction terms are significant and negative); or the effects are smaller among individuals with "advantageous" statuses (the coefficients of interaction terms are significant and positive).

"Resource Multiplication" hypothesis: The effects of education are stronger among individuals with "advantageous" statuses in economic resources or social relationships (the coefficients of interaction terms are significant and negative) or the effects are smaller among individuals with "disadvantageous" statuses (the coefficients of interaction terms are significant and positive).

2. THE PATHWAYS BETWEEN EDUCATION AND DEPRESSION

1) Economic and Work Pathway

Taiwanese with higher levels of education are less likely to be depressed at initial levels than their counterparts because they tend to avoid economic disadvantages such as economic hardship and unfavorable work-related conditions such as work dissatisfaction. Both of the factors considerably increase depression. Table 6.1 indicates that economic disadvantages—economic hardship and lower levels of income—explain 50% of the educational effects in the 2005 TSCS samples (100 x [-.197-(-.099)/-.197], from Model 1 to Model 2 of the coefficient of *Education*). Furthermore, work dissatisfaction mediates an additional 10% of the educational effects (100 x [-.089-(-.080)/-.089], from Model 3 to Model 4 of the coefficient of *Education*) when economic conditions have been previously adjusted. The pattern is also found in the Taiwanese elderly panel samples. Table 6.2 shows that 42% of the educational effects (100 x [-1.599-(-.922)/-1.599], from Model 1

Table 6.1: Depression (Square-Root) Regressed on Education, Potential Economic Mediators, Social Relationships, and Alienation, Adjusting for Demographic Variables: Taiwan, 2005 TSCS (N = 2,131).

Variables	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8
Education [a]	-.197***	-.099***	-.089**	-.080**	-.075**	-.074**	-.079**	-.033
	(-7.091)	(-3.410)	(-3.115)	(-2.836)	(-2.625)	(-2.602)	(-2.793)	(-1.172)
Eco. Mediators								
Economic		.095***	.052***	.048***	.048***	.048***	.047***	.033**
Hardship		(9.982)	(5.017)	(4.622)	(4.627)	(4.624)	(4.520)	(3.257)
Lowest 3rd		.030	.008	.013	.006	.006	.003	.003
Income [b]		(1.344)	(.362)	(.568)	(.388)	(.246)	(.156)	(.115)
Missing		.013	.005	.008	.009	.007	.017	.023
Income [b]		(.344)	(.122)	(.207)	(.241)	(.187)	(.456)	(.656)
Economic			.140***	.101***	.100***	.098***	.093***	.082***
Dissatisfy			(9.025)	(6.125)	(6.027)	(5.899)	(5.655)	(5.084)
Work				.101***	.102***	.100***	.098***	.081***
Dissatisfy				(6.086)	(6.109)	(6.017)	(5.928)	(4.970)
Rel. Mediators								
Single [c]					-.016	-.018	-.008	-.005
					(-.504)	(-.574)	(-.238)	(-.170)
Divorced [c]					.069	.063	.071	.041
					(1.269)	(1.148)	(1.320)	(.777)
Widowed [c]					.089*	-.023+	.100*	.100*
					(2.070)	(-1.883)	(2.353)	(2.398)
Support						-.023+	-.014	-.003
						(-1.883)	(-1.156)	(-.208)
Negative							.070***	.065***
Interaction							(5.788)	(5.484)
Alienation								
Powerless								.012*
								(2.175)
Mistrust								.011+
								(1.798)
Normless								.011+
								(1.955)
Meaningless								.050***
								(7.385)
Demo. Variables								
Age (10^{-2})	-.503***	-.446***	-.368***	-.326***	-.379***	-.380***	-.288**	-.267**
	(-6.408)	(-5.776)	(-4.832)	(-4.293)	(-3.877)	(-3.888)	(-2.937)	(-2.755)
Age^2 (10^{-3})	.034	.029	.037	.033	.035	.038	.026	.020
	(1.026)	(.895)	(1.182)	(1.062)	(.922)	(.999)	(.693)	(.538)
Female (=1)	.047*	.054**	.063**	.065***	.058**	.062**	.054**	.053**
	(2.431)	(2.863)	(3.390)	(3.514)	(3.111)	(3.271)	(2.856)	(2.878)
Mainlander	.001	.014	-.002	-.002	-.001	-.004	-.013	-.014
(=1)	(.035)	(.442)	(-.051)	(-.074)	(-.045)	(-.124)	(-.419)	(-.445)
Intercept	.603***	.301***	.230***	.170***	.173***	.227***	.177***	.314***
	(35.428)	(9.167)	(6.937)	(4.946)	(5.002)	(5.048)	(3.899)	(6.635)

R^2	.035	.084	.118	.133	.135	.137	.150	.190

Notes: Unstandardized coefficients with t-statistics in parentheses shown. Age is centered as 45.
a. Education years is modeled as (Education – the sample mean of education) x 10^{-1}.
b. Compared to respondents who are equal or over the middle third of the household income level.
c. Compared to respondents who are married.
$^{+}$ p < .10; * p < .05; ** p < .01; *** p < .001.

to Model 2 of the coefficient of *Education* on *Depression Level*) on the predicted constant of depression are mediated by economic hardship, income, and financial and property investment. After the adjustment of economic disadvantages, about an additional 4% (100 x [-.922-(-.882)/-.922], from Model 2 to Model 3 of the coefficient of *Education* on *Depression Level*) are explained by low occupational prestige and unemployment.

On the other hand, these economic and work characteristics do not explain the effects of education on the declining slope of change in depression. The effects of education on the depression slope remain almost identical after the adjustment of baseline economic hardship, fluctuation of economic hardship over time, low income, and the dummy variable of financial and property investment. The coefficients of education on the depression slope are estimated as -.061 in both Model 1 and Model 2 in Table 6.2. Furthermore, low occupation prestige and unemployment merely explain around an additional 2% reduction of educational effects (100 x [-.061-(-.060)/-.061], from Model 2 to Model 3 of the coefficient of *Education* on *Depression Slope*). As a result, the reasons that Taiwanese with higher levels of education have lower rates of depression change over the life course are outside of economic and work advantages. This implies that the impact of education on the preservation of psychological well-being over time is idiosyncratic.

Taken as a whole, Taiwanese with more education years are less depressed than their counterparts partially because they have more economic and work advantages that benefit emotional well-being. Moreover, education seems to instill individuals with a specific ability independent of economic advantages that makes depression lessen over

Table 6.2: Level and Slope of Depression Regressed on Age, Education, Potential Economic Mediators, and the Interactions of Education with Economic Disadvantage Statuses, Adjusting for Demographic Variables, based on a Multi-Indicator Structural Equation Model with Time Centered on Mid-Follow-Up: Taiwan, the Elderly and Middle-Aged Data (N =6,511).

Variables	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7
LEVEL							
(Age-70) x 10^{-2}	.722***	.866***	.787***	.770***	.775***	.794***	.882***
	(13.566)	(15.233)	(13.283)	(13.028)	(13.076)	(13.232)	(15.758)
(Age-70) ^{2} x 10^{-2}	-.007$^+$	-.006	-.007	-.006	-.007$^+$	-.006	-.004
	-1.867	(-1.499)	(-1.644)	(-1.437)	(-1.694)	(-1.564)	(-1.056)
(Education-6) x 10^{-2}	-1.599***	-.922***	-.882***	.051	-.822***	-.682***	-.155
	(-12.946)	(-6.790)	(-6.430)	(.238)	(-5.419)	(-3.707)	(-.746)
Educ. x Age x 10^{-2}	-.012	-.019	-.025*	-.025*	-.023*	-.019	-.022$^+$
	(-1.118)	(-1.642)	(-2.166)	(-2.165)	(-1.968)	(-1.536)	(-1.901)
Economic Hardship		.197***	.192***	.178***	.192***	.192***	.187***
		(24.694)	(24.124)	(21.121)	(24.123)	(24.119)	(22.792)
Lowest 3rd Income [a]		.032**	.022$^+$	.020$^+$	.011	.020$^+$	
		(2.781)	(1.900)	(1.740)	(.783)	(1.704)	
Missing Income		.002	-.001	-.003	-.005	-.006	
Information [a]		(.144)	(-.082)	(-.166)	(-.316)	(-.340)	
Non-Investor (=1)		.070***	.066***	.071***	.069***	.070***	
		(5.115)	(4.865)	(5.248)	(4.469)	(5.196)	
Lowest 3rd of			.028*	.027*	.028*	.021	
Occ. Index (=1)			(2.481)	(2.463)	(2.562)	(1.625)	
Out of the Labor			.061***	.062***	.062***	.056***	
Force (=1)			(5.882)	(6.040)	(6.053)	(5.154)	
Resource Substitution							
Education x				-.095***			-.090***
Hardship x 10^{-1}				(-5.817)			(-5.599)
Educ. x Lowest					-.033		
3rd Inc. x 10^{-1}					(-1.174)		
Educ. x Non-					-.006		
Investor x 10^{-1}					(-.175)		
Educ. x Lowest						-.029	
3rd of Occ. x 10^{-1}						(-1.048)	
Educ. x Out of the						-.033	
Lab. Force x 10^{-1}						(-1.429)	
Female (=1)	.115***	.133***	.133***	.130***	.132***	.134***	.134***
	(11.383)	(12.298)	(12.381)	(12.075)	(12.192)	(12.432)	(12.553)
Mainlander (=1)	.033*	.049***	.040**	.041**	.039**	.042**	.053***
	(2.523)	(3.360)	(2.738)	(2.829)	(2.673)	(2.837)	(3.782)
Intercept	.307***	.055***	.029*	.038**	.030*	.032*	.077***
	(35.171)	(4.251)	(2.123)	(2.766)	(2.214)	(2.329)	(6.036)
Residual Variance	.072***	.073***	.071***	.071***	.071***	.071***	.071***
	(22.545)	(23.308)	(23.266)	(23.200)	(23.262)	(23.258)	(23.194)
R^2	.211	.373	.380	.391	.381	.382	.373

SLOPE							
(Age-70) x 10^{-2}	.041**	.066***	.071***	.068***	.068***	.067***	.054***
	(3.197)	(4.371)	(4.612)	(4.623)	(4.571)	(4.549)	(3.665)
(Age-70) ^{2} x 10^{-2}	.001*	.002**	.002**	.002**	.002**	.002**	.002**
	(2.370)	(2.720)	(2.750)	(2.997)	(2.919)	(2.934)	(2.608)
(Age-70) ^{3} x 10^{-4}	-.009*	-.013**	-.014**	-.014**	-.014**	-.014**	-.012**
	(-2.194)	(-2.916)	(-3.125)	(-3.068)	(-3.082)	(-3.065)	(-2.707)
(Educ.-6) x 10^{-2}	-.061***	-.061***	-.060**	-.042	-.066***	-.067***	-.088***
	(-4.059)	(-3.297)	(-3.211)	(-1.296)	(-3.757)	(-3.801)	(-5.051)
Educ. x Age x 10^{-2}	-.006***	-.006***	-.005**	-.006**	-.006***	-.006***	-.006***
	(-3.849)	(-3.390)	(-3.155)	(-3.238)	(-3.302)	(-3.300)	(-3.428)
Economic Hardship		-.004**	-.004**	-.003*	-.004**	-.004**	-.005***
		(-2.792)	(-2.740)	(-2.497)	(-2.807)	(-2.825)	(-4.685)
Rising Economic		.017***	.017***	.017***	.017***	.017***	
Hardship [b]		(8.035)	(7.976)	(7.417)	(8.003)	(8.029)	
Falling Economic		-.003	-.003	-.003	-.003	-.003	
Hardship [b]		(-1.030)	(-.985)	(-.858)	(-.986)	(-.965)	
Lowest 3rd Income [a]		.003	.003				
		(1.553)	(1.578)				
Missing Income		.000	.000				
Information [a]		(.108)	(-.107)				
Non-Investor (=1)		-.003	-.003				
		(-1.427)	(-1.412)				
Lowest 3rd of			.001				
Occ. Index (=1)			(.340)				
Out of the Labor			-.001				
Force (=1)			(-.830)				
Resource Substitution							
Education x				-.002			
Hardship x 10^{-1}				(-.834)			
Education x Rising				.000			
Hardship x 10^{-1}				(-.034)			
Education x Falling				.000			
Hardship x 10^{-1}				(-.023)			
Intercept	.004***	.006***	.007***	.006**	.006***	.006***	.011***
	(4.277)	(3.394)	(3.417)	(3.283)	(3.581)	(3.566)	(6.401)
Residual Variance	.001***	.001***	.001***	.001***	.001***	.001***	.001***
	(8.240)	(8.493)	(8.539)	(8.623)	(8.546)	(8.580)	(8.772)
R^2	.050	.116	.116	.111	.113	.113	.067
Residual Covariance	.001***	.001***	.001***	.001***	.001***	.001***	.001***
FIT STATISTICS							
χ^2	166.868	463.466	504.181	574.073	527.698	526.921	276.111
Df	78	128	144	175	167	167	95
CFI	.997	.990	.990	.992	.992	.992	.995
NFI	.994	.986	.986	.989	.988	.988	.993
RMSEA	.013	.020	.020	.019	.018	.018	.017

Note: Metric coefficients with Critical-ratio in parentheses. Full Information maximum-likelihood is used to correct for attrition (assuming MAR).

a. Compared to respondents who are equal or above middle third of the income level.

b. Compared to respondents with stable economic hardship over time.

time. Conversely, Taiwanese with less education years face a double jeopardy: they are not only more likely to be associated with economic disadvantages or unfavorable work conditions that threaten psychological well-being, but also to lack the protection of specific educational resources that diminish the increase of depression over time.

Additionally, the significant estimated effects of a number of the hypothetical economic and work mediators on depression are noteworthy. Of these economic disadvantages, economic hardship and economic dissatisfaction appear to mediate much of educational effects and also substantially influence depression itself. Economic hardship and economic dissatisfaction—the mediator that explains 45% of effects of economic hardship (100 x [.095-(.052)/.095], from Model 2 to Model 3 of the coefficient of *Economic Hardship* in Table 6.1)—both display strong and consistent effects on depression levels in all analyses. However, the effects of economic hardship on the depression slope become negative, implying that the adverse impacts of economic hardship diminish over time. It is plausible that people with higher levels of economic hardship gradually become used to their difficulties. Meanwhile, Taiwanese with higher levels of work dissatisfaction demonstrate significantly higher levels of depression than their counterparts. Work dissatisfaction is usually connected to alienation from jobs with insufficient creativity and autonomy (Ross and Van Willigen 1997). As a result, 17% of the effects of work dissatisfaction (100 x [.098-(.081)/.098], from Model 7 to Model 8 of the coefficient of *Work Dissatisfaction* in Table 6.1) are reduced after the adjustment of four types of alienation: powerlessness, mistrust, normlessness, and meaninglessness. Unfortunately, the relationships among work dissatisfaction, alienation, and depression are unable to be further examined in this research because of the absence of direct measurements of work conditions in the TSCS sample.

2) Social Relationships Pathway

Does education shape social relationships that benefit psychological well-being in Taiwan, a country in which families are highly integrated? Or, are education and social relationships independent of each other? In order to clarify this question, this section assesses the mediating effects of various forms of social relationships—children's education, co-residence, marital status, social support, and familial negative interaction—on the patterns between education and depression.

First of all, children's education and co-residence between elderly and adult children are two of the most specific factors that impact depression in the collectivist society of Taiwan. However, their effects on the patterns between education and depression differ. For the Taiwanese elderly, having a highly educated child explains 16% of the educational effects on the depression constant (100 x [-1.599-(-1.345)/-1.599], from Model 1 to Model 2 of the coefficient of *Education* on *Depression Level* in Table 6.3). The results suggest the combined effects of the education of older adults and their adult children on psychological well-being. Elderly with more education years are not only less depressed but also tend to benefit from having a highly educated child, who represents the potential resources that elderly can rely on when they need and symbolizes the additional protection that facilitates the prevention of higher initial levels of depression of elderly. Nonetheless, child's education suppresses the educational effects on the depression slope (the magnitude of coefficient of *Education* increased from -.061 of Model 1 to -.065 of Model 2 in Table 6.3) and does not impact on the depression slope itself. This implies that the respondent's own education still plays a crucial role in preventing the progression of depression. In other words, the education of older adults, rather than their children' education, is the main resource utilized in confronting internal demoralization over the life course.

Table 6.3: Level and Slope of Depression Regressed on Age, Education, and Potential Social Resources Mediators, Adjusting for Demographic Variables, based on a Multi-Indicator Structural Equation Model with Time Centered on Mid-Follow-Up: Taiwan, the Elderly and Middle-Aged Data (N=6,511).

Variables	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7
LEVEL							
(Age-70) x 10^{-2}	.722***	.739***	.743***	.706***	.746***	.765***	.721***
	(13.566)	(13.475)	(13.368)	(11.902)	(14.767)	(15.255)	(13.733)
(Age-70) ^{2} x 10^{-2}	-.007$^+$	-.006	-.005	-.006	-.005	-.005	-.007$^+$
	-1.867	(-1.519)	(-1.345)	(-1.415)	(-1.366)	(-1.263)	(-1.854)
(Education-6) x 10^{-2}	-1.599***	-1.345***	-1.370***	-1.388***	-1.642***	-1.650***	-1.507***
	(-12.946)	(-10.002)	(-10.033)	(-9.879)	(-8.888)	(-7.451)	(-11.533)
Educ. x Age x 10^{-2}	-.012	-.011	-.013	-.013			
	(-1.118)	(-.972)	(-1.166)	(-1.140)			
Having Child with 13+Educ. Years [a]		-.067***	-.067***	-.070***	-.060***		
		(-6.403)	(-6.368)	(-6.433)	(-5.636)		
No Child [a]		.070*	.056$^+$	.065$^+$	.080**		
		(2.277)	(1.752)	(1.945)	(2.625)		
Live with/ Contact Child Daily (=1)			-.033**	-.039**		-.040***	
			(-2.608)	(-2.980)		(-3.387)	
Widowed (=1)				.037**			.006
				(2.859)			(.440)
Resource Substitution							
Educ. x H-Educated Child x 10^{-1}					.057*		
					(2.546)		
Educ. x Live with or Contact child x10^{-1}						.005	
						(.199)	
Educ. x Widowed x 10^{-1}							-.066*
							(-2.364)
Female (=1)	.115***	.130***	.134***	.131***	.128***	.121***	.114***
	(11.383)	(12.348)	(12.504)	(11.521)	(12.107)	(11.665)	(10.732)
Mainlander (=1)	.033*	.031*	.028*	.033$^+$	.031*	.026*	.035*
	(2.523)	(2.298)	(2.014)	(2.274)	(2.261)	(1.961)	(2.684)
Intercept	.307***	.329***	.354***	.351***	.322***	.336***	.302***
	(35.171)	(33.305)	(25.404)	(24.505)	(31.214)	(26.254)	(33.822)
Residual Variance	.072***	.074***	.076***	.079***	.074***	.074***	.074***
	(22.545)	(22.924)	(23.022)	(23.154)	(22.919)	(22.769)	(22.786)
R^2	.211	.229	.233	.237	.231	.218	.218
SLOPE							
(Age-70) x 10^{-2}	.041**	.043**	.045**	.041**	.044**	.044***	.037**
	(3.197)	(3.158)	(3.286)	(2.841)	(3.258)	(3.295)	(2.760)
(Age-70) ^{2} x 10^{-2}	.001*	.001*	.001*	.002**	.001**	.001*	.001*
	(2.370)	(2.418)	(2.442)	(2.638)	(2.573)	(2.362)	(2.500)
(Age-70) ^{3} x 10^{-4}	-.009*	-.008*	-.008*	-.008$^+$	-.009*	-.009*	-.008*
	(-2.194)	(-2.015)	(-1.995)	(-1.775)	(-2.076)	(-2.122)	(-1.979)
(Education-6) x 10^{-2}	-.061***	-.065***	-.060***	-.053**	-.058***	-.019	-.039*
	(-4.059)	(-3.911)	(-3.789)	(-3.189)	(-3.747)	(-.602)	(-2.093)
Educ. x Age x 10^{-2}	-.006***	-.006***	-.006***	-.005***	-.006***	-.006***	-.005***

	(-3.849)	(-3.771)	(-3.477)	(-3.295)	(-3.708)	(-3.725)	(-3.316)
Having Child with 13+Educ. Years [a]		.001 (.635)					
No Child [a]		-.007 (-1.486)					
Live with or Contact Child Daily (=1)			.004* (2.067)	.004* (2.053)		.003 (1.535)	
Widowed (=1)				.002 (.960)			.001 (.503)
New Widowed (=1)				.006* (2.534)			.004 (1.567)
Resource Substitution							
Educ. x Live with or Contact Child x 10^{-1}						-.004 (-1.262)	
Educ. x Widowed x 10^{-1}							-.005 (-1.052)
Educ.x New Widow x 10^{-1}							-.004 (-.828)
Intercept	.004*** (4.277)	.004*** (3.399)	.002 (1.150)	.001 (.374)	.005*** (4.369)	.003 (1.536)	.003** (3.004)
Residual Variance	.001*** (8.240)	.001*** (8.185)	.001*** (8.169)	.001*** (8.126)	.001*** (8.231)	.001*** (8.206)	.001*** (8.171)
R^2	.050	.054	.055	.060	.051	.053	.056
Residual Covariance	.001***	.001***	.001***	.001***	.001***	.001***	.001***
FIT STATISTICS							
χ^2	166.868	241.882	291.823	491.387	253.067	253.698	388.252
df	78	94	104	121	106	95	113
CFI	.997	.995	.994	.989	.996	.996	.993
NFI	.994	.992	.990	.985	.993	.993	.990
RMSEA	.013	.016	.017	.022	.015	.016	.019

Note: Metric coefficients with Critical-ratio in parentheses. Full Information maximum-likelihood is used to correct for attrition (assuming MAR).

a. Compared to those whose highest-educated child's education is less than 13 years.

Subsequently, Taiwanese elderly with more education years receive less beneficial effects of co-residence on the predicted constant of depression because they are less likely to live with their children or have daily contact with their children. Table 6.3 indicates that the magnitude of the coefficient of education on the depression level slightly increases from -1.345 in Model 2 to -1.370 in Model 3. As a result, were it not for differences in the likelihood of co-residence, the effects of education on depression level would be even slightly bigger. Additionally, co-residence is not the major factor

Table 6.4: Level and Slope of Depression Regressed on Age, Education, Social Relationships Disadvantage, and The Interactions of Education with Relationships Disadvantage, based on a Multi-Indicator Structural Equation Model with Time Centered on Mid-Follow-Up: Taiwan, the Elderly and Middle-Aged Data (N=6,511).

Variables	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7
LEVEL							
(Age-70) x 10^{-2}	.722***	.467***	.497***	.483***	.487***	.795***	.786***
	(13.566)	(7.617)	(7.986)	(8.499)	(8.618)	(15.233)	(15.600)
(Age-70) ^{2} x 10^{-2}	-.007$^+$	.009*	.008$^+$	.010*	.009*	-.001	-.006$^+$
	-1.867	(2.104)	(1.839)	(2.323)	(2.174)	(-.304)	(-1.646)
(Educ. -6) x 10^{-2}	-1.599***	-1.533***	-1.520***	-3.309***	-3.305***	-1.615***	-1.481***
	(-12.946)	(-10.977)	(-10.813)	(-5.471)	(-5.575)	(-11.326)	(-4.607)
Educ. x Age x 10^{-2}	-.012	-.013	-.016				
	(-1.118)	(-1.027)	(-1.294)				
Social Support		-.221***	-.198***	-.211***	-.208***		
		(-19.506)	(-15.053)	(-17.518)	(-17.481)		
Relationships			.048***			.126***	
Dissatisfy (=1)			(3.393)			(9.834)	
Familial Criticism			.061***				.075***
Exposure			(5.319)				(7.173)
Resource Substitution			.				
Education x Social				.073**	.073**		
Support x 10^{-1}				(3.088)	(3.142)		
Educ. x Relation.						-.012	
Dissatisfy x 10^{-1}						(-.444)	
Educ. x Familial							-.012
Criticism x 10^{-1}							(-.557)
Female (=1)	.115***	.121***	.123***	.120***	.121***	.128***	.121***
	(11.383)	(10.584)	(10.684)	(10.466)	(10.599)	(11.705)	(11.596)
Mainlander (=1)	.033*	.031*	.030$^+$	.032*	.030*	.045**	.031*
	(2.523)	(1.984)	(1.927)	(2.067)	(1.972)	(3.107)	(2.282)
Intercept	.307***	.821***	.670***	.794***	.789***	.264***	.205***
	(35.171)	(28.438)	(17.166)	(25.859)	(25.973)	(27.306)	(12.441)
Residual Variance	.072***	.089***	.091***	.089***	.087***	.082***	.075***
	(22.545)	(23.616)	(23.910)	(23.597)	(23.517)	(23.673)	(23.076)
R^2	.211	.282	.287	.283	.288	.244	.228
SLOPE							
(Age-70) x 10^{-2}	.041**	.051**	.053***	.051**	.052***	.045**	.044**
	(3.197)	(3.191)	(3.297)	(3.219)	(3.328)	(3.122)	(3.239)
(Age-70) ^{2} x 10^{-2}	.001*	.001	.001	.001	.000	.002**	.002*
	(2.370)	(.784)	(1.026)	(.869)	(.618)	(2.745)	(2.590)
(Age-70) ^{3} x 10^{-4}	-.009*	-.004	-.004	-.004	-.004	-.007	-.009*
	(-2.194)	(-.792)	(-.790)	(-.827)	(-.934)	(-1.617)	(-2.155)
(Educ.-6) x 10^{-2}	-.061***	-.075***	-.066***	-.068	-.085***	-.052**	-.067
	(-4.059)	(-4.206)	(-3.711)	(-.609)	(-4.782)	(-2.634)	(-1.230)

Educ. x Age x 10^{-2}	-.006***	-.006***	-.006**	-.006**	-.006**	-.006***	-.006***
	(-3.849)	(-3.494)	(-3.174)	(-3.048)	(-3.188)	(-3.318)	(-3.697)
Social Support		.011***	.014***	.010***	.012***		
		(5.598)	(6.058)	(5.047)	(7.167)		
Rising Support [a]		.000	.004	.000			
		(-.168)	(1.266)	(-.118)			
Falling Support [a]		.018***	.008**	.017***			
		(6.254)	(2.620)	(5.329)			
Relationships			.009**			-.001	
Dissatisfy (=1)			(3.093)			(-.457)	
Rising Relation.			.017***			.017***	
Dissatisfy [b]			(6.366)			(6.978)	
Falling Relation.			-.012***			-.004	
Dissatisfy [b]			(-3.625)			(-1.336)	
Familial Criticism			-.003				-.002
Exposure			(-1.294)				(-1.236)
Rising Familial			.006**				.007***
Criticism [c]			(2.666)				(3.412)
Falling Familial			-.003				-.002
Criticism [c]			(-1.196)				(-.959)
Resource Substitution							
Education x Social				.000			
Support x 10^{-1}				(-.056)			
Education x Rising				.001			
Support x 10^{-1}				(.098)			
Educ. x Falling				-.007			
Support x 10^{-1}				(-.991)			
Educ. x Relation.						-.006	
Dissatisfy x 10^{-1}						(-1.011)	
Educ. x Rising						.001	
Dissatisfy x 10^{-1}						(.157)	
Educ. x Falling						.008	
Dissatisfy x 10^{-1}						(1.152)	
Educ. x Criticism							.001
Exposure x 10^{-1}							(.256)
Educ. x Rising Crit.							.000
Exposure x 10^{-1}							(-.083)
Educ. x Falling Crit.							.002
Exposure x 10^{-1}							(.407)
Intercept	.004***	-.020***	-.027***	-.020***	-.022***	.004**	.007*
	(4.277)	(-4.204)	(-4.015)	(-3.736)	(-5.350)	(3.053)	(2.586)
Residual Variance	.001***	.001***	.001***	.001***	.001***	.001***	.001***
	(8.240)	(8.064)	(7.775)	(8.052)	(8.163)	(8.081)	(7.997)
R^2	.050	.107	.159	.106	.078	.104	.069
Residual Covariance		.001***	.001**	.001***	.002***	.001*	.001***
FIT STATISTICS							
χ^2	166.868	689.870	969.156	741.052	376.859	853.283	397.439
df	78	104	156	131	96	131	131
CFI	.997	.982	.982	.990	.994	.983	.995

NFI	.994	.978	.979	.987	.993	.980	.992
RMSEA	.013	.029	.028	.027	.021	.029	.018

Note: Metric coefficients with Critical-ratio in parentheses. Full Information maximum-likelihood is used to correct for attrition (assuming MAR).
a. Compared to those with stable social support over time.
b. Compared to those with stable dissatisfaction over time.
c. Compared to those with stable familial criticism over time.

that influences the patterns between education and the depression slope since the coefficients of education on Model 1 and Model 3 in Table 6.3 remain similar. However, although living with children or daily contact with children increases the prevention of the higher levels of depression levels, it results into higher rates of depression change over time. The plausible reason is that co-residence causes the reduction of autonomy and the increased likelihood of trivial household conflicts such as disagreements about housework arrangements.

Marital status, social support, and negative familial relationships are also considered. In the 2005 TSCS sample, marital status only explains 6% of educational effects on depression (100 x [-.080-(-.075)/-.080], from Model 4 to Model 5 of the coefficient of *Education* in Table 6.1) when economic and work conditions are controlled. In the elderly panel samples, Taiwanese with more education years have lower levels of initial depression because they are less likely to be widowed, as indicated by the increasing coefficient of education on depression level from Model 3 to Model 4 in Table 6.3. Nonetheless, the effects of education on the depression slope decrease over time because the more educated are more likely to lose spouse during follow-up surveys.

Social support is a robust indicator of depression, but not the most influential mediator of the education-depression associations. Table 6.1 shows that social support only explains 1 % of the net effects of education outside of the influence of economic, work, and marital status (100 x [-.075-(-.074)/-.075], from Model 5 to Model 6 of the coefficient of *Education* in Table 6.1). Likewise, Table 6.4 demonstrates that 4% of

educational effects on depression level (100 x [-1.599-(-1.533)/-1.599], from Model 1 to Model 2 of the coefficient of *Education* on *Depression Level*) are due to social support. However, were it not for the effects of social support, education would have an even greater effects on the depression slope, as indicated by the increasing size of coefficients of education on depression slope from Model 2 to Model 3 in Table 6.4. As individuals receive social support, they obtain accompanying expectations from their families and friends. It is possible that people feel they have to overcome their obstacles so they will not let their supporters down. Consequently, social support occasionally results into stress and increases the progression of depression.

Last but not least, Taiwanese elderly with more years of education have lower levels of initial depression. They are less likely to be dissatisfied with their relationships and to experience familial criticism, although the magnitude of explanation is trivial. The size of coefficients of education on depression level decreases from -1.533 in Model 2 to -1.520 in Model 3 in Table 6.4. On the other hand, 12% of the net effects of education outside of social support on the depression slope (100 x [-.075-(0.066)/-.075], from Model 2 to Model 3 of the coefficient of *Education* on *Depression Slope*) are due to relationship dissatisfaction and familial criticism exposure and their temporal patterns. It seems that Taiwanese elderly maintain lower levels of unfavorable relationships over time. However, the findings of the 2005 TSCS sample conflict with the assumption that education increases the likelihood of supportive interpersonal relationships. This is indicated by the growing size of coefficients of education Model 6 to Model 7 in Table 6.1. There are two plausible reasons. First, Taiwanese with higher levels of education are less likely to suppress their emotions, so they have higher likelihoods of arguments with their families. Second, they have a tendency to "report" more negative interactions within

their family than their counterparts. Unfortunately, TSCS dataset does not provide enough information for further elaboration.

Taken together, the mediating effects of social relationships on the patterns between education and depression are relatively small in Taiwan, which suggests that the main part of educational effects on depression are independent of those of social relationships in a society with high degree of family cohesion. Meanwhile, as expected, social relationships themselves play a strong role in the prevention of high levels of initial depression. Nonetheless, the progression of depression over time is much less influenced by beneficial social relationships such as children's education, co-residence, and social support. The coefficients of these factors on depression are generally nonsignificant or positive, as indicated in Table 6.3 and Table 6.4. The results reflect that education is a special protective resource that restricts the progressionof depression.

3) Alienation Pathway

The 2005 TSCS sample provides an opportunity to observe whether the beneficial effects of education on depression are partially due to that fact that well-educated Taiwanese are less likely to be associated with alienation such as powerlessness, mistrust, normlessness, and meaningless. The results of Model 8 in Table 6.1 show that 58% of the net educational effects outside of economic and social relationships characteristics are explained by the above four forms of alienation (100 x [-.079-(-.033)/-.079], from Model 7 to Model 8 of the coefficient of *Education*). After the adjustment of alienation, the coefficient of education even becomes nonsignificant. Taken together, education seems to make people believe in their own ability to solve difficulties, trust other people or even social systems, think that the things are going as expected, and believe that life is

intelligible. All of these psychological characteristics enhance the preservation of psychological well-being. As a result, Taiwanese with more education are less depressed.

Unfortunately, due to the absence of alienation measurements in the longitudinal panel samples, this research is unable to further ascertain the causal relationships among education, alienation, and depression in Taiwan.

3. RESOURCE SUBSTITUTION OR RESOURCE MULTIPLICATION

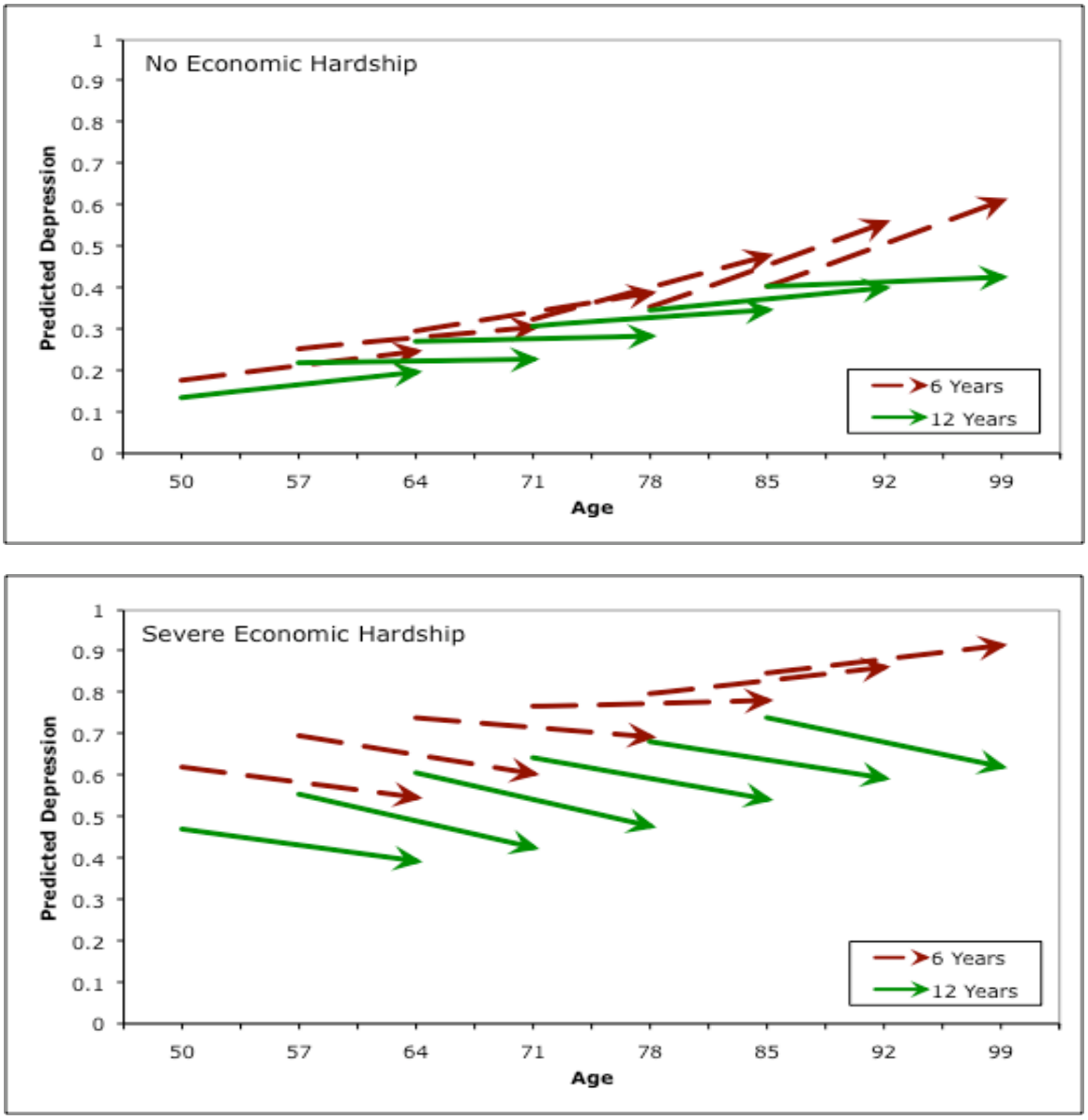
Table 6.2, Table 6.3 and Table 6.4 demonstrate the estimated effects of interaction terms of education and different types of disadvantageous statuses on levels and slopes of depression in the elderly panel samples. In terms of the estimations of the depression constant, the observed patterns mainly support the hypothesis of resource substitution and contradicts the hypothesis of resource multiplication. That is, the negative association of depression with education on the predicted depression level is greater for Taiwanese with higher economic hardship, those without highly educated children, those who lost spouse, and those with lower levels of social support. However, in some cases, neither hypothesis is substantiated. As indicated by the nonsignificant estimates of interaction terms, the strength of association between education and depression is not contingent on differences in income levels, occupational prestige, residence status, relationships dissatisfaction and familial criticism exposure.

Table 6.2 displays in detail the estimates of the interaction between education and disadvantage status in economic resources and the resulting effect on depression. Although the interaction of education and economic hardship with respect to the depression constant is the only significant one, it provides remarkable empirical evidence to support resource substitution theory. The negative and significant coefficient of the interaction of Model 7, -.009, means that education reduces depression levels more as the

degree of economic hardships increases. In other words, the effects of education on the depression constant is 6.8 times bigger as the levels of economic hardship increases from 0 to 1 unit ((-.00155+(-.009))/-.00155).

Figure 6.1 visualizes the results of Model 7 of Table 6.2. The top panel compares the differences of the projected aging vectors between individuals with 6 education years and those with 12 education years, when the level of economic hardship is fixed at 1 (represents "no economic hardship" according to the economic hardship index introduced in the measurement section of Chapter 3). The bottom panel shows the differences of aging vectors across levels of education when the level of economic hardship is fixed at 3 (represents "severe economic hardship"). The combined information from these two panels underscores three phenomena. First of all, elderly with severe economic hardships are more depressed than their counterparts with no economic hardship, regardless of education levels. Next, the differences of depression levels across levels of education are greater among elderly with severe economic hardship. In essence, for individuals with no economic hardship, depression increases over the life course for both education groups and the education-based gap in depression is very small in middle ages. The gap does not diverge significantly until the very late segment of the life course. Conversely, for individuals with severe economic hardship, depression decreases by age in the middle adulthood with similar rates for both education groups. However, the absolute magnitude of education-based disparity on depression levels is substantial during this period. In late life, the increase of depression emerges for individuals with 6 education years but not for those with 12 education years, resulting in the greatest education-based divergence. Third, the changing slopes of depression differ considerably by levels of economic hardship among elderly with more education years. The more-educated elderly with no economic hardship tend to maintain stable levels of depression over the life course. But

Figure 6.1: Vector Graphs of Predicted Level and Slope of Depression by Economic Hardships and Education.



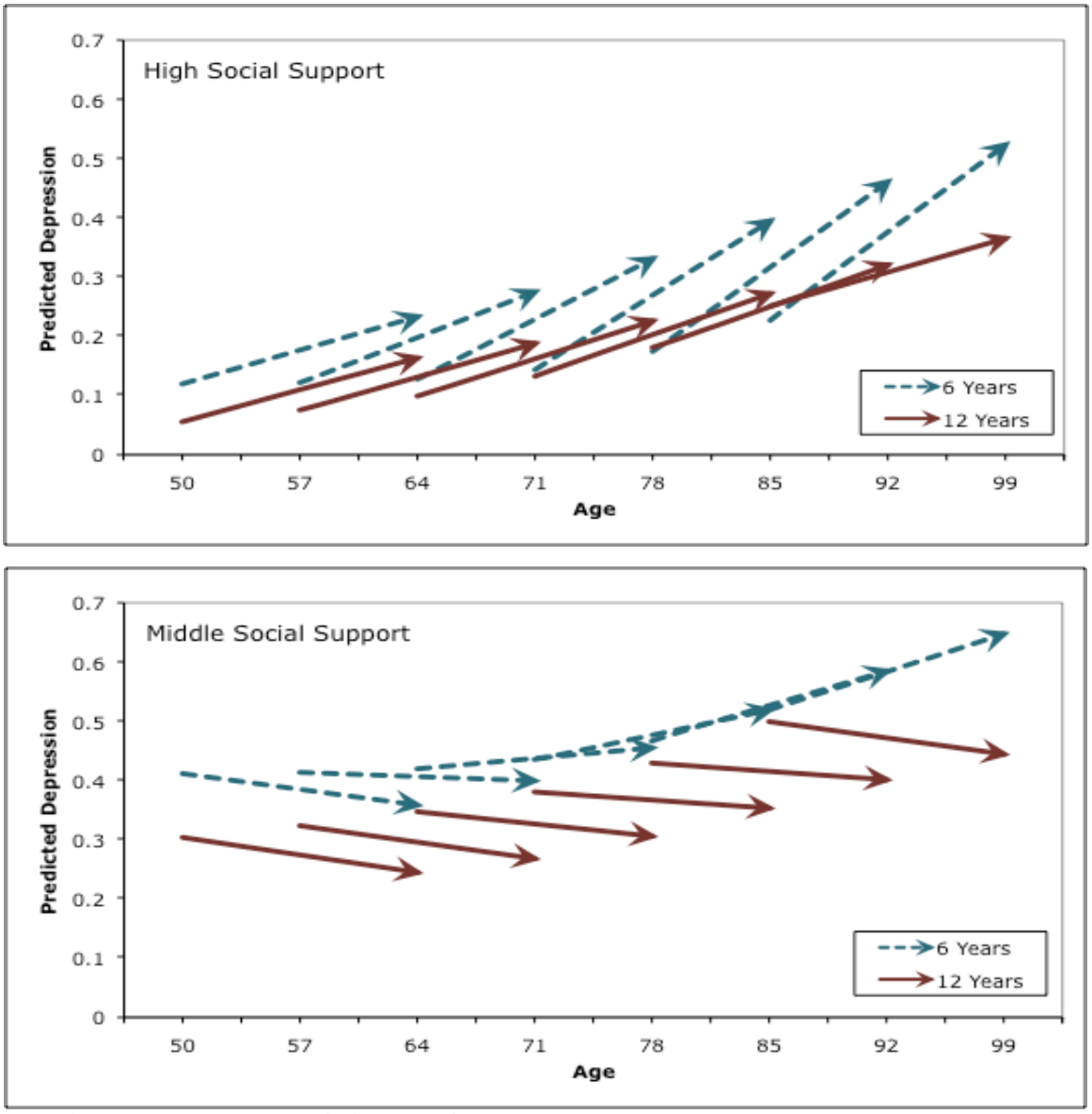
Note: Corresponding to Model 7 of Table 6.2.

for those more-educated elderly with severe economic hardship, depression diminishes over time. Taken as a whole, the effects of education are greater for elderly in economic disadvantage such as economic hardship.

Likewise, Table 6.3 reports the empirical support of resource substitution hypothesis with respect to children's education and widowhood. In Model 5, the positive coefficient of the interaction between one's own education and one's children's education on depression level suggests that the effects of one's own education on the prevention of high level of depression are smaller if older adults have "advantage" in their children's education. Meanwhile, as suggested by the negative coefficient of interaction between education and widowhood with respected to depression level in Model 7, the effects of education become greater for widows, which is a "disadvantageous" status. Both findings support the hypothesis of resource substitution theory. Nonetheless, the effects of education remain the same regardless of residence status, as indicated by the nonsignificant coefficient of interaction of Model 6.

The effects of education are also smaller among people with a higher degree of social support, although the effects do not differ across levels of relationships dissatisfaction or levels of familial criticism exposure, as reported in Table 6.4. For instance, Model 5 reports the significant and positive coefficient of interaction between education and social support as .0073. This suggests that the effects of education on the depression constant is .78 times smaller as the 1-unit increase of the level of social support increases ((-.03305+(.0073))/-.03305). Figure 6.2 illustrates the results of Model 5. The most striking finding is that depression decreases over time for the 12-years-educated elderly with a middle degree of social support. However, depression increases over time for those at the same education levels but with a high degree of social support. As a result, the effects of education are stronger for those with less social support, consistent with the hypothesis of resource substitution.

Figure 6.2: Vector Graphs of Predicted Level and Slope of Depression by Social Support and Education.



Note: Corresponding to Model 5 of Table 6.4.

4. SUMMARY

Taiwanese with more education years are less depressed because they tend to avoid unfavorable economic and work conditions and prevent alienation symptoms in

powerlessness, mistrust, normlessness, and meaninglessness. However, the effects of education on depression are only slightly mediated by social relationships. In other words, education is not the main factor that decides people's access to supportive relationships in the collectivist society of Taiwan.

However, education is the most influential protective resource. First, education is the only factor that consistently displays significant and negative effects with respect to the slope of depression change in all analyses. Education prevents the internal progression of depression. Other factors such as children's education or social support usually impact on the predicted depression constant, which leads to the structural differences in depression. Second, as expected in the resource substitution hypothesis, the effects of education are greater for individuals with less advantage in economic or social relationships resources. As a result, education is an inalienable resource that effectively substitutes other absent resources.

Chapter 7: Disscussion and Conclusion

Three core research themes are comprehensively elaborated in this study, including (1) whether depression changes across segments over the adult life course in Taiwan and whether the denoted aging trajectory in depression is altered by the influence of cohort variations. In addition, what factors account for the shape of the denoted trajectory? (2) whether education influences depression in the multi-dimensional aspects in Taiwan, including the prevention of initial depression, the reduction of depression progression over time, the function of resource substitution for other disadvantageous status, and the rising importance of educational effects across the life course and across cohorts; and (3) whether education is the overall root cause of various social factors linked to depression—economic status, work conditions, children's education, co-residence, loss of spouse, social support, relationships dissatisfaction, familial criticism exposure, and alienation—and under what circumstances does education display unique impacts other than these social factors. The findings are generally consistent with the hypotheses derived from previous studies based on Western populations. Nonetheless, the differences of patterns between Taiwan and Western societies are also observed and are detailed in the following sections.

Aging Trajectory in Depression in Taiwan

This study establishes a composite image of depression change across segments over the adult life course in Taiwan by encompassing three approaches. To begin, this research examines several combinations of linear and curvilinear aging functions on six cross-sectional samples with different age structures. Previous studies reported inconsistent results of the shape of aging trajectories because they used aging functions

differentially on samples truncated by various ages (Kessler et al. 1992; Mirowsky and Ross 1992). As a consequence, this approach makes this research provides more reliable estimation. The convergent results of these samples demonstrate the parabolic patterns of depression decreasing and then surging in successive Taiwanese age groups. That is, depression is lowest among the middle aged, higher among younger and older adults, and highest among the oldest-old, as indicated in Chapter 4.

Second, with regard to the significant cohort differences resulted from tremendous social change in Taiwan, the repeated cross-sectional data are pooled to distinguish aging effects and cohort effects. The results shown in Chapter 5 indicate that ignoring cohort effects leads to the underestimation of the aging effects and attenuates the apparent rise of depression in old age. The findings here complement the similar phenomenon discovered in the research of self-reported health based on the U.S. population (Lynch 2003) and underscore the importance of integrating life-course perspectives and cohort perspectives to improve the precision of estimations.

Moreover, with regard to the seeming attrition of the most depressed elderly in late life (Mirowsky and Kim 2007; Mirowsky and Reynolds 2000; Yang 2007), the aging vector analyses with FIML estimations are utilized on the longitudinal elderly samples. As illustrated in Chapter 5, the slope of depression trajectory in late life is much steeper for the sets of vectors with information of respondents died within the period of observation than the slope for the vectors without decedents, implying that the ignorance of attrition issues results in the underestimation of rising depression in late adulthood.

Taken together, the combined findings leave limited doubt that average depression increases steeply across the last few segments of adult life course in Taiwan, complementing to the similar patterns found from several analyses focused on different nationally representative samples of the US population (Kim 2006; Miech and Shanahan

2000; Mirowsky and Reynolds 2000; Mirowsky and Ross 1992). In terms of theoretical aspects, the results reflect that rising depression in old age is not a "scientific myth" (Feinson 1985), but that depressive symptoms seem to be an inevitable concomitant of older age across societies. Furthermore, in terms of the aspects of policy making, the results suggest that the Taiwanese government should be alerted that depression is a developing social problem requiring more attention. As an aging society (e.g., according to Executive Yuan (2007), average life expectancy at birth for female peaks at 80.8 in 2006), how to postpone the upsurge in depression in late adulthood at the individual levels and how to reduce the prevalence of depression at the aggregate levels are both emergent concern.

The Explanations of Five Aging Views

The aging trajectories in depression are established by factors associated with historical trends in education, differential survivals, life stage, health decline, and maturity, as discussed in Chapter 4. First and more importantly, the results demonstrate considerable evidence for the "age as historical trends" hypothesis. As a proxy of historical trends, education accounts for 32% to 44% of the rising depression in late adulthood in three examined samples, reflecting greater differences in life conditions across generations in Taiwan. Moreover, the magnitude of effects of education on depression are statistically greater than those displayed in previous U.S. studies (Mirowsky and Ross 1992; Schieman, Van Gundy, and Taylor 2001; Yang 2007). It suggests that variations across cohorts are probably greater in Taiwan than those in the U.S. Second, "age as life stage" factors such as economic hardship in late life, retirement, and widowhood and "age as decline" risk factors such as physical dysfunction and life-threatening diseases effectively explain the rise in depression in successive age groups,

but their effects are partially cancelled by the emotional benefits of 'maturity" over the life course. Nevertheless, although sex partially explains the rising curve in late life, the overall test only slightly supports the view of "age as differential survival".

The Multi-Dimensional Effects of Education

The study of the educational impacts on depression is essential because education is the unique socioeconomic status that effectively eliminates depression stratification at the aggregative level and prevents an upsurge in depression at the individual level. First, education is more accessible than other SES status in Taiwan (Hsieh et al. 1999) although inequality of educational opportunity still exists (Tsai 2004). Almost every individual is able to get at least nine years compulsory formal education (Hsieh et al. 1999) and has a chance to develop problem-solving abilities instilled with in the process of learning (Mirowsky and Ross 1998). As a result, education is a means toward well-being for every individual. Second, at the individual level, unlike external resources such as income, education is an inalienable resource that cannot be taken away. A person's education is a constituent part of the person and exists in every stage of the life course (Ross and Mirowsky 2006). The effects of education can be found in every subpopulation in the society. As a consequence, this study centers on the systematical examination of the multi-dimensional relationships between education and depression in Taiwan.

The Association between Education and Depression

To begin with, this research answers to the most foundational question: Does education matter to depression in Taiwan? In terms of the levels of depression, the results indicate the significant and consistent effects of education in all analyses, regardless of

utilized models and samples. Taiwanese with more education years are less depressed than their counterparts, although at least 40% effects of education are mediated by the avoidance of economic disadvantage such as economic hardships. Nonetheless, education is not the only crucial social cause. For instance, other factors, including economic hardships, work dissatisfaction, adult child's education, widowhood and several types of social relationships also substantially affect the constant of depression.

However, with respect to the effects on hindering the progression of depression over time, education is the most particular and influential resource. In the aging vectors results, education consistently predicts the lower slope of depression, which is an association mainly independent of other social factors. Conversely, other health-enhancing resources such as social support and co-residence do not reduce the progression of depression over time. As a result, although education is not the only social factor that prevents higher initial levels of depression, it is the most prominent one that diminishes following growth of depression over time.

The Strength of the Association between Education and Depression

Whether the strength of the relationship between education and depression depends on other social factors is also ascertained. The results demonstrate that the interactions between education and other economic or social status in their effects on depression indicate resource substitution rather than resource multiplication. Education is more important to the emotional well-being of individuals with disadvantageous status in economic and social aspects than of their counterparts with advantageous status. In other words, the educational differences in depression are greater for those who have already suffered from the adverse effects from different types of disadvantages. According to the theory of learned effectiveness (Ross and Mirowsky 2006), education is the internal

ability that helps people meet situations effectively and turns existing things into resources. If so, the more external health-enhancing resources are blocked or lost, the more important education becomes to their well-being. As a result, education reduces depression more for those with severe economic hardships and with less supportive relationships. In contrast, the educational gap in depression attenuates or vanishes among those with other resources. People with less economic hardships, more social support, and a highly educated child are less likely to rely on education for their psychological well-being. Taken together, education provides consequential protection against psychological distress for those who most lack health-enhancing resources.

The Life Course Patterns in the Relationships Between Education and Depression

This study provides new evidence for the hypothesis that successful postponement of depression to older ages is partially contingent on education. Past literature over the last two decades suggests that the cumulative advantage theory and age-as-lever theory are two competing hypotheses for why educational differentials in physical health or mortality strengthen over the life course (Lauderdale 2001; Lynch 2003; Ross and Wu 1996) or decline in late life (Beckett 2000; House et al. 1990; House, Lantz, and Herd 2005). The major reasons for the inconsistency are attributed to selective mortality occurred in cross-sectional data, the differences of the level of analyses (e.g., prevalence, incidence, or duration), and ignoring cohort effects (Dupre 2007; Lynch 2003). This study extends the discussion to the field of depression—a rarely-examined health outcome in this type of research (Miech and Shanahan 2000)—and to Taiwan, a non-Western setting.

The core findings support the cumulative advantage theory. While the depression trajectories for all educational levels surge as individuals enter old age, the magnitude of

progression of depression is significantly lower for those with higher educational attainment, leading to divergent differences in late life at the individual level. The findings are important because of two reasons. Theoretically, the force of selection in old age—poor health increases the inability or unwillingness to participate in the survey—compresses the differences in health across levels of education (Beckett 2000; Beckett and Elliott 2001; Herd 2006; Noymer 2001). If so, then the divergence founded in this study should be even larger. Methodologically, the results based on the aging vector models with FIML estimations are relatively valid. In this type of method, the influence of mortality selection—decreasing educational disparities are compositional artifacts resulting from selective mortality caused by a cumulative disadvantage in the onset of disease and survival—is lessened because the information of decedents have been imputed and then included in the analyses (Lynch 2003; Mirowsky and Kim 2007; Wothke 2000).

Moreover, the interaction terms between education and age with respect to the slope of depression are consistent and significant in all analyses of this study and are mainly independent of physical impairment, chronic diseases, demographic background, and other social characteristics. It provides new insights into the literature since the temporal patterns between education and depression have never been examined in non-Western societies. Nonetheless, although the divergent patterns with respect to the depression constant are similar between Taiwan and U.S. societies, the pattern with respect to the slope of depression differs. Comparing with the increasing effects of education on depression slope over time in Taiwan, the decreasing effects of education on depression slope over the life course are founded in U.S. research using the same approaches (Kim 2006). Future study should clarify whether this inconsistency is caused

by cultural differences or just due to different age structures of the samples or dissimilar variables used in statistical models.

The Rising Importance of Educational Effects Across Cohorts

The effects of education are more salient for younger generations in Taiwan, consistent with the rising importance theory. The results in the TSCS samples clearly demonstrate that educational impact on depression is greater in successive younger cohorts. Meanwhile, the aging vector analyses based on the elderly samples also demonstrate that a favorable trend toward lower depression across cohorts for those with more education years. Given the rising levels of education in Taiwan, its rising importance to depression may seem beneficial. Unfortunately, it actually reflects a trend toward faster progression of depression at lower levels of education. The similar patterns have been found in the self-reported health and mortality studies in the U.S. (Lauderdale 2001; Lynch 2003; Pappas et al. 1993). In the times when health-improving knowledge and medical technology is more advanced, mortality rate is falling for everyone, and the overall material environment is improving, individuals with higher education attainments are more likely to maintain good health, including psychological well-being.

It is important to note that the number of higher education institutions in Taiwan has increased dramatically in the last decade and peaks at about 150 schools in 2000 (Tsai 2004). The current younger generations are able to easily access higher education. Two questions therefore merit attention. First, at the aggregate level, do the rise of average education years and the increase of numbers of individuals with college degrees really eliminate educational inequality in depression? Subsequently, at the individual level, is "years of education" still the robust predictor of depression for the future generations? Alternatively, do "prestige of the schools" or "types of schools (e.g.,

national versus private; university versus technology college) become more valid measurements? As a result, future work should refine the association between education and health by assessing the effects of educational quantity, selectivity, and credential for more recent generations (Ross and Mirowsky 1999).

The Unique Taiwanese Phenomena

This study extends the theories derived from the Western paradigm to the collectivist society of Taiwan and discovers some unique social patterns. In the begining, past studies focused on U.S. population suggested that education is the fundamental social cause that helps individuals establish economic, work, marital, and social relationships that enhance physical health and ameliorate psychological distress (Link and Phelan 1995; Ross and Van Willigen 1997). Nonetheless, in Taiwan, although education substantially reduces distress by way of economic resources, economic dissatisfaction, and work dissatisfaction, the extent to which it reduces distress by way of marital status (or widowhood), social support, and negative interactions within the family are much smaller. It seems that the effects of institutional resources such as education and the effects of familial resources such as social support are independent of each other. The reason is probably that supportive relationships are the expected behaviors in Taiwan and are not fundamentally stratified by levels of education.

Second, the education of one's children has a strong association with psychological well-being of the older adult in Taiwan, which is a society characterized by high degrees of family integration. On the one hand, having a child with a highest level of education is negatively associated with depression levels. Since education can be regarded as a family resource rather than as an individual resource (Zimmer, Hermalin, and Lin 2002a; Zimmer et al. 2007), the result suggests that children provide or

symbolize additional protective resources that are beneficial to the mental health of their parents. On the other hand, this study finds that having a child with ties to the highest level of education has no impact on the slope of depression over time, which is opposite to the findings of physical health and mortality that children's education has stronger impacts (even more important than older adult's own education) on the progression of physical health problems and on the mitigation of the effect of diseases on mortality (Zimmer, Hermalin, and Lin 2002a; Zimmer et al. 2007). Because depression is an individual experience, one's own ability or control is still the main reason to decide whether individuals are able to overcome the internal progression of depression. Resources from familiar members probably have more impacts on the elimination or the prevention of the stressors of environments and only affect initial levels of depression.

In terms of the relationships between education and depression over the life course, this study finds the directions of trajectories across levels of education in early adulthood are different in the U.S. and Taiwan. In the study based on the U.S. sample, the U-shaped aging trajectories in depression are observed for all educational levels (Miech and Shanahan 2000). Nonetheless, the opposite patterns are found in the TSCS samples. That is, well-educated Taiwanese are more depressed in early adulthood than their counterparts with less education years. The pattern is reversed as people enter middle life. The plausible reason is that the pace of the life course depends on education. The well-educated Taiwanese are generally in school and delay the development of resources in marital, economic, and work aspects in early adulthood. Fortunately, with the development of resources, depression of the well educated gradually declines over the life course. Conversely, the less educated are more likely to be employed and married in their early life, both of which improve emotional well-being. Unfortunately, perhaps the relatively stagnant accumulation of resources over the life course does no meet the

parallel increasing difficulties in supporting a family (e.g., the rising costs for their children's education and their aging parents' medical services). Hence, for the less educated, depression increases over the life course. Further empirical investigation is absolutely necessary because the current study is not designed to thoroughly elaborate what mechanisms lead to this particular phenomenon in the early adulthood.

Limitations

Due to the limitations of the data, three important issues have not been comprehensively examined in this study. First and foremost, alienation—powerlessness, self-estrangement, mistrust, meaninglessness, and normlessness—are regarded as one of the most important links between social factors and depression (Mirowsky and Ross 2003b). Resulting impacts vary across the life course and changes under different circumstances (Mirowsky and Ross 2007). Unfortunately, the questions that are designed to measure levels of alienation are missing in the surveys this research uses. Therefore, future Taiwanese research not only needs to collect but also have to develop specialized measurements for these alienation forms to clarify the dynamic relationships among social factors, alienation, and psychological distress.

Second, the longitudinal data utilized in this research only include cohorts born before 1946. Whether the aging vectors phenomena found in these samples of older cohorts can be replicated in the samples that include younger generations remains unknown. Moreover, whether the importance of educational effects increases among most recent Taiwanese generations is unable to be examined in this research. As a result, future surveys designed for younger cohorts are necessary.

Ultimately, the impacts of work characteristics—job autonomy, nonroutinized work, home-to-work conflicts, and competitive work environments—on emotional well-

being and their mediating effects on the relationships between education and depression merit more and more attention in the recent studies (Ross and Wu 1995; Schieman 2002; Schieman, McBrier, and Van Gundy 2003). The influence of work characteristics may be a more meaningful issue in contemporary Taiwan. For instance, with the dramatic development of the technology industry in Taiwan, becoming computer or electronics engineers is a popular career choice. Engineers are also clearly associated with higher levels of education, income and annual bonus, and work creativity, all of which improve emotional well-being substantially. Conversely, they also face higher risks of health problems due to an extremely competitive work environment and prolonged work hours. It is hence essential for further studies to clarify the relationships among education, occupational attributes, and emotional well-being.

Conclusion

Depression is not merely personal misery. Instead, depression is a tangible outcome that records how social factors have deeply influenced an individual's personal life throughout their life course. Several noteworthy findings underscore the importance and the uniqueness of educational impacts on psychological well-being. Although education is not the only beneficial social cause on psychological well-being, it is the most significant one. Its effects not only strengthen across the life course and are stronger for those under difficult times. Education provides consequential protection against depression.

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Vita

Wei-Pang Wang was born in Changhua, Taiwan, on April 24, 1979, the son of Chu-Yin Wu and Yen-Pin Wang. After completing his work at Viator Junior and Senior High School in Taichung, Taiwan, in 1997, he entered National Chengchi University in Taipei, Taiwan. He received the degrees of Bachelor of Arts in Sociology and in Political Science from National Chengchi University in June 2001. During the following year, he was employed as a research assistant at Institute of Sociology, Academia Sinica, Taipei. In September 2002, he entered the Graduate School of the University of Texas at Austin. He received the degree of Master of Arts from the University of Texas at Austin in August 2005. He continued the doctoral program of the University of Texas at Austin in September 2005.

Permanent address: No. 48-22, Jhonghe Rd.
Tsaotun, Nantou, 542, Taiwan

This dissertation was typed by the author.