J. of Population Studies
20 : 35-62, 1999, Population and Gender
Studies Center, NTU.

Population Aging and Changes in Dependency Ratios in Taiwan

Chaonan Chen* Huoying Wu** George Lee***

(ABSTRACT)

This paper analyzes the trends of three dependency measures in Taiwan to observe their relationships and to contemplate their economic implications. The findings indicate that Taiwan's population is aging much faster than that of the United States, and that the shift from more young and less elderly to less young and more elderly dependents will accelerate in the near future.

It was also found that there have been no significant differences between the labor-force-participation adjusted dependency ratio (LADDR) and the expenditure adjusted dependency ratios (LEADDR) in Taiwan in the past two decades. These ratios were found to be about three times as large as the crude demographic dependency ratios (CDDR). Whether the consistent and stable relationship in Taiwan between LADDR and CDDR is due to Taiwan's specific conditions or whether there is a systematic functional relationship between the two measures is an issue that needs further study. Finally, the changes in population composition and expenditure indicate that Taiwan's family burden during the past two decades has been gradually eased because the high consumption group has decreased in size while the low consumption group has increased in size.

Key words: Aging, dependency ratio, labor force participation, family expenditure

* Research Fellow, Institute of Economics, Academia Sinica.
** Assistant Research Fellow, Institute of Economics, Academia Sinica.
*** Professor of International Business and US-Soviet Institute, College of Business, San Francisco State University.

人口學刊第 20 期
頁 35-62，民國 88 年 10 月
台北：台大人口與性別研究中心

台灣人口老化與依賴比之變化

陳肇男*　吳慧瑛**　黎成信***

（中文摘要）

本文旨在分析台灣三種依賴比之長期趨勢，以便探討三者之關係及其經濟涵義。本文發現台灣之人口老化速度遠快於美國人口之老化。在可見的未來，台灣將從年輕依賴人口多但老年依賴人口少的情況加速轉型爲年輕依賴人口少，但老年依賴人口多之情況。

本文也發現在過去二十年中，勞動參與率調整後之依賴比與家庭消費調整後之依賴比，二者並無顯著差異。二者大致約爲粗人口依賴比之三倍。勞動參與率調整後之依賴比與粗人口依賴比之穩定關係是台灣所獨有的，或是二者之間存有一系統性函數關係則有待進一步之研究。最後，台灣人口組成與家庭消費之變化情形顯示過去二十年裡，台灣之家庭負擔逐漸減輕，起因是高消費人口群減少，但低消費人口增加。

關鍵詞：人口老化、依賴比、勞動參與率、家庭消費

*　中央研究院經濟所研究員
**　中央研究院經濟所副研究員
***　舊金山州立大學商學院教授兼美蘇研究所所長

J. of Population Studies
20 : 35-62, 1999, Population and Gender
Studies Center, NTU.

Populaton Aging and Changes in Dependency Ratios in Taiwan

Chaonan Chen* Huoying Wu** George Lee***

Society's economic burden is an issue of increasing concern to developing economies, which have reached the late phase of demographic transition, and are now planning to extend their coverage of public pension systems. The crude demographic dependency ratio (CDDR) is a useful indicator of the economic burden of a society. This ratio has an advantage over more complex dependency ratios due to its wide accessibility, making international comparisons possible. Moreover, for developing economies with only rudimentary data, the CDDR can be useful for purposes of social policy design. However, Adamchak and Friedmann (1983) point out that this indicator neglects variations in labor participation rates and expenditures based on age groups, the ensuing distortion being especially significant when there are substantive changes in the elderly/youth dependent proportion. This criticism suggests that CDDRs should be adjusted for variations in labor participation rates and age-group expenditures.

This study examines and compares Taiwan's dependency ratios to see how changes in labor participation rates and variations in expenditure affect society's economic burden. That is, for the period 1976-1995, we calculate and compare three dependency ratios: (1) the CDDR, (2) a second ratio, a labor participation-adjusted demographic dependency ratio (LADDR), and (3) a third ratio, a CDDR adjusted for both labor participation and for expenditures (LEADDR).

We also examine the long-term trends of these ratios, their correlation, as well as the differential effect of using each of these ratios to calculate society's economic burden. We find that, while a more comprehensive dependency ratio should include adjustments for both expenditures and labor-participation rates, in Taiwan's case, the ratio of LEADDR to CDDR is almost constant, averaging 2.93 with an average annual variation

* Research Fellow Institute of Economics, Academia Sinica
** Assistant Research Fellow Institute of Economics, Academia Sinica
*** Professor International Business and US-Soviet Institute, College of Business, San Francisco State University

of less than 0.12% per year. The relatively stable relationship between the CDDR and more comprehensive dependency ratios, such as the LEADDR, means that, if data such as expenditures based on age groups are not available, as is the case in many developing economies, the CDDR may still be useful when designing social economic policies.

I. Review of the Literature

The process of population aging is of economic significance since it affects individual behavior, which in turn influences economic and other characteristics of a population and its economy. Population aging changes the dependent/working age ratio, the size of the labor force, labor productivity, income distribution, and consumption, etc. (United Nations 1956, U. S. Bureau of the Census 1976, chapters. 5,6).

The sharp increase in elderly dependents in the United States received much attention after the release of a working paper by the U.S. President's Commission on Pension Policy (1980), which noted that the proportion of population aged 65 and over in the United States increased from 4% in 1900 to 11% in 1980, and would rise to 23% in 2035. This implies that — assuming that the retirement age remains at 65 — U.S. society's economic burden will grow as the proportion of working (18-64) to retired (65 and over) people decreases. The report predicted that this ratio would fall from 5.5 in 1980 to 2.5 in 2035. That is, in 1980, one elderly dependent was supported by 5.5 working people, but by the year 2035, only 2.5 working people would be supporting each elderly dependent. Given the rapid increases in health care costs at present, the implications for U.S. society's economic burden could be even more serious than the doubling of the elderly dependency ratio would indicate.

A population's age composition is influenced by the mortality, fertility and migration rates. In today's industrialized countries, fertility changes — as reflected by the gross reproduction rate — is the dominant determinant of changes in the age structure (Coale 1972, Coal and Demeney 1966, Keyfitz 1968, and United Nations 1968). Since further reduction in mortality in modernized countries may be limited (Preston et al. 1972 and U.S. Census 1976) and prospective legal migration is small, fertility will continue to be the dominant determinant of age composition in industrialized countries for the foreseeable future.

Continuing falls in fertility rates, approaching a replacement level, combined with stable but low mortality rates, would lead to a change in the dependent population composition. This change has two economic implications. First, depending on the balance between the decrease in young dependents and the increase in elderly dependents, the demographic dependency ratio may or may not change. If the increase in the latter supersedes the decrease in the former, the dependency ratios will increase. Second, the dependency burden may vary because of different public and private expenditures according to age groups. In general, the cost of children is regarded as an investment, but costs for the elderly are considered to be pure consumption. Therefore, increased expenditure on the elderly may have a negative impact on economic development.

In principle, ceteris paribus, a stationary population's potential productive capacity and ability to maintain a high worker/dependent ratio is at or near a peak. For instance, if fertility is at replacement level, working age males, say, aged 18-64, may comprise 60% of the population. However, if the population is growing at 0.5% per year, the corresponding working male population would be less, say, 58% (Coale and Demeny, 1966). The labor force dependency ratio is 67 for the former and 72 for the latter.

In the case of the United States, the U.S. Bureau of the Census (1975) made projections to the year 2050 based on the following assumptions: a net annual immigration of 400,000, a mean childbearing age of 26, total fertility at 2.1 and slight increases in life expectancy. The projected population composition of series II can be summarized as follows:

1. The 0-17 age group would decrease from 31% in 1975 to a near stable level of around 25% by 2050.
2. The 65 and over age group would increase steadily from 10% in 1975 to a near stable level of 16% by the year 2050.
3. The 18-64 age group would increase slightly from 59% in 1975 to 61% in the years 1990 and 2000, and then decrease to 59% by the year 2050.
4. The crude dependency ratio would decrease from 71 in 1975 to 63 in 2000, and then increase to 69 again.

Although the labor force dependency ratio reflects the social burden more

accurately than the crude demographic dependency ratio, the U.S. Census' study contained little analysis as to how total labor force dependency ratios will change in the United States from 1990 to 2050, i.e., during the period of accelerating population aging. Such an analysis may have been left out because of the innate difficulty in accurately projecting labor force variables.

Sheppard and Rix (1977), based on the projections of Marc Rosenblum, projected a decline in the total labor force dependency ratio from 114 in 1980 to 103 in 2010. The ratios for 2020 and 2040 were 112 and 115, respectively, as derived from Johnson's projections. Another projection, made by Adamchak and Friedmann (1983), was based on Fullerton's assumptions (1980), which assumed a higher percentage of female and minority labor participation rates. They projected that the total labor force dependency ratio would decline slightly from 127 in 1980 to 85.5 in 2050, if the age of eligibility for social security remained at 65. The results of the two projections differ because of differing assumptions. Although it is the functional relationships among various measures that constitute one of the major concerns of this study, no stable relationship between the two projected labor force dependency ratios and the crude demographic dependency ratio was observed.

Whether labor force participation will follow one or the other of the above projections, the future of the dependency burden on the working population also hinges on the relative costs of supporting young versus elderly dependents. Clark and Spengler (1978) estimated that governmental expenditures per elderly dependent amount to about three times as much public money spent per young dependent. With the shift from young dependents to more elderly dependents, the required level of total governmental support would increase from 14.2% of disposable personal income in 1974 to 16.2% in 2050. They also noted that private spending is more important for the support of the young than for the elderly. When both private and public expenditures are included, the total cost of an elderly dependent is only about 50% higher than that of a young dependent.

Schulz, Borowski and Crown (1991) used Consumer Expenditure Survey (CES) data to estimate private expenditures for young and elderly dependents, as well as the working age group. They then used the estimates as weights to adjust the labor force

dependency ratio, resulting in the so-called expenditure-adjusted dependency ratio, which they forecast would decline from 104 in the decade 1960-1970 to 60 in the period 2000-2025, and then increase to 73 in the period 2025-2050.

While an expenditure adjusted dependency ratio would differ from the CDDR, if there is a definite, predictable functional relationship between these ratios, then when the CDDR is known, we can, for purposes of assessing society's economic burden, adjust that ratio to estimate the expenditure adjusted dependency ratio. For example, Schulz et al. (1991) compared their results with the labor force dependency ratio of the United States, and concluded that the two measures have similar, parallel trends. They also found that the total dependency ratio will be lower when members of the baby boom retire than it was when these baby boomers were children in the 1950s and 1960s.

Finally, Adamchak and Friedman (1983) pointed out that the concepts of "generational transfers" that calculate "dependency ratios" in terms of funds from the public sector have two limitations. First, such calculations ignore the transfer of goods and services from productive to dependent groups in the family and other networks outside the public sector. Secondly, the value of voluntary contributions of goods and services produced outside the market economy are also excluded. Adamchak and Friedmann (1983) propose "a societal dependency ratio" to include both public and private costs. They estimate a societal dependency ratio for the United States that will decline from 46.1 in 1990 to 43.0 in 2010, and then increase to around 49.0 in 2050. Unfortunately, this report did not show the methodology used to calculate this ratio.

II. Data and Method

The data for this study are obtained from four sources. Basic age compositions from 1952 to 1995 are available from the Taiwan-Fukien Demographic Fact Book (Ministry of Interior, Republic of China). Population projections are prepared by the Council for Economic Planning and Development(CEPD), Executive Yuan, ROC. Based on the population composition of 1990, three series of population projections ranging from low to high growth are made available to the year 2050. In this study, only projections of medium growth are used to calculate the crude demographic dependency ratio.

Data concerning labor force participation and expenditures are obtained from two series of surveys conducted by the Directorate-General of Budget, Accounting and Statistics (DGBAS). One is the monthly manpower survey, which began in 1964. This survey has a sample size as large as some 50,000 persons. One half of the sample is rotated every month. Here only labor force sizes are used. The other series is the Survey of Family Income and Expenditure which is similar to the Consumer Expenditure Survey (CES) conducted in the United States. This survey was started in 1976. It has a sample size ranging from 9,446 to 16,434 households. Both kinds of survey have a two stage stratified random sample design. The primary sampling units used are the village and household for the two stages.

The surveys of Family Income and Expenditure provide household expenditures as a whole, and these can't be separated into individual costs. To produce separate estimates of the expenditure for the three age groups, it is first necessary to partition the survey data into three mutually exclusive data files: households with younger adults only, households with younger adults and children, and households headed by older persons. The elderly file is used to calculate the annual mean expenditures of the elderly.

To estimate the costs of children separately from the expenditures on their parents, the method proposed by Schulz et al. (1991) is adopted. The procedure can be briefly described as follows. The data file for households with young adults only is used to estimate a consumption function by means of ordinary least squares (OLS). The data file for households with young adults and children is used to tabulate expenditure on children that could be readily identified (for example, boys' and girls' clothing, toys and infant formula). An adjusted total consumption variable is then created with total household expenditure minus the identifiable expenditure on children. The consumption function acquired from the data file for households with young adults only is used to regress the adjusted total consumption variable against household income, number of children in the household, size of urban area, and education of household head and his wife. This procedure can be expressed as in equation 1 of Appendix A. Family size is identified as the number of children in a household plus the number of adults (see equation 2 of Appendix A). Total household expenditures are then estimated by multiplying equation 1 of Appendix A by the identity in equation 2 of

Appendix A (see equation 3 of Appendix A). Adult expenditures that would take place if there were no children in the household are then estimated. This is accomplished in equation 4 of Appendix A. Expenditures on children are estimated by subtracting estimated adult expenditures from total expenditures (see equation 5 of Appendix A). Mean per capita expenditures on children are estimated by summing estimated child expenditures and directly-tabulated expenditures (see equation 5 of Appendix A). Mean per capita expenditures of young adults are then derived by taking the weighted average of the two estimates of expenditures of young adults from the files of households of young adults, both with and without children.

In this paper, only the mean per capita expenditures of the three age groups are reported. Since the estimation procedures are tedious and the results are voluminous, only the regression results for one selected year are presented in Appendix B.

This method, however, has an acknowledged disadvantage — insensitivity to what Schulz et al. (1991) called the "substitution effect". Take expenditures on cloth for example. If there had been an expected rise in total clothing expenditures, it may have been held in check by substituting expenditures on children for those on adult clothing. Since our methodology does not make allowance for substitution effects, it may systematically underestimate expenditures on children. However, other methods, e.g. equivalence scales (Van der Gagg 1982), tend to overestimate the expenditures on children. Consequently, this method is believed to be useful in providing a lower-bound for expenditures on children.

On the other hand, we feel that this method provides an upper bound for the costs of the elderly in Taiwan. It estimates the expenditures of elderly people living independently. Living independently is much more expensive than living with children because there are no cost-sharing and substitution effects. In Taiwan, the proportion of elderly who live either alone or with their spouses only has increased from about one-tenth in the 1970s to one-third in the 1990s (Chen 1996). So, the majority of elderly people in Taiwan spend less than our estimate would suggest.

III. Trends in Demographic Dependency Ratios

The pattern of Taiwan's post-demographic transition demographic dependency

ratios differs from that of the United States. The difference is primarily caused by a difference in terms of the pace of the demographic transition. While it took about 80 years for Taiwan to reach the late phase of demographic transition (Chen et al. 1986), the same process took about 200 years in most Western countries. Since the pace of transition is positively related to the rapidity of population aging, the key issue of concern here is the sharp shift from young dependents to elderly dependents.

Taiwan's mortality began declining in the first decade of the 20th century. Fertility, however, did not begin to decrease quickly until the mid-1960s when a powerful family planning program was instituted and the ROC's export-push policies began Taiwan's economic takeoff. The combination of high fertility, low mortality (see Figure 1) and full-employment caused Taiwan's CDDR to reach its peak in the mid-1960s.

During the two decades that followed, fertility dropped quickly to approach a replacement level, but mortality remained low; thus Taiwan's population transition was completed in the mid-1980s. During this thirty-years period, Taiwan's CDDR declined sharply, from 94.2 in 1962 to 53.1 in 1985, mostly owing to the decrease in young dependents aged 14 or less. Over the next decade, the process of population aging began with slight increases in elderly dependency accompanied by a slow decline in youth dependency. These changes caused the CDDR to drop slightly to 45.8 in 1995. That is, ten years after moving into the late phase of demographic transition, Taiwan's change in its CDDR paralleled that of the US's post-population transition development (Adamchak and Friedmann, 1983).

In the future, however, Taiwan's projected demographic dependency ratio will begin to differ from that of the United States. In the two decades after 1995, young dependents will continue to decline moderately, but elderly dependents will slightly increase. From 1995 to 2015, Taiwan's dependency pattern will remain similar to that of the United States, but after 2015 Taiwan's elderly dependents will increase more and more rapidly. In 2025, Taiwan's elderly dependency ratio will exceed the corresponding youth dependency ratio for the first time (see Figure 1). The gap will widen gradually so that by 2036, the ratios are expected to be 35.37 and 28.0 for elderly and youth dependency, respectively. In sum, Taiwan's total dependency ratio will be

dominated by elderly dependency after 2015. The primary reasons for these trends in Taiwan are increasing life spans, decreasing fertility and the aging of the babyboom cohort.

The United States dependency pattern, however, will differ from that of Taiwan. Elderly dependency will accelerate for ten years and then begin to level off. While the youth dependency ratio will also flatten out, it will remain higher than the elderly dependency ratio. The gap, according to Adamchak and Friedmann (1983), stays at 18. Neither young nor elderly dependents dominate the U.S. total dependency ratio.

IV. Labor Force Adjusted Dependency Ratio Trends

The labor force dependency ratio is the ratio of non-working to working population. The non-working population has three components, young dependents, working age people not participating in the labor market, and elderly dependents. The working population includes all who participate in the labor force, regardless of age.

In Taiwan, when the number of births was relatively large in the 1960s and early 1970s, the labor force dependency ratio was dominated by young dependents, who accounted for about two-thirds of total labor force dependency (see Table 1 and Figure 2). Youth dependency, however, decreased as fertility declined. By 1971, working-age dependents had increased slightly, primarily due to the extension of compulsory education from 6 years to 9 years beginning in 1968 and the rising enrollment rates for high school and post-secondary education. Working-age dependency then continued to decline as women's labor force participation grew. During this period, youth dependency decreased much faster than the drop in working-age dependency, the two dependency categories becoming equal by 1991. Thereafter, working-age dependency exceeded youth dependency because of the baby boom of the 1950s.

Elderly dependency was negligible prior to the completion of the demographic transition in Taiwan. In 1964, the elderly labor force dependency ratio was only 7.4, accounting for 3.4% of total dependency. Elderly dependency, however, was increasing. Beginning in 1979, the elderly dependency ratio exceeded 10 and its share of total dependency increased to about 6%. By 1995, it had increased to 16.4, accounting for 12.4% of total dependency.

In brief, from 1964 to 1995, the total labor force dependency ratio dropped sharply, from 220.5 to 131.7, caused mainly by the substantial decrease in young dependents. By 1995, working-age dependents became the major component of the labor force dependency ratio. In 1995, the respective shares of youth, working-age adults and elderly were 42%, 46% and 12%.

This pattern differed somewhat from what was happening in the United States. In 1980, the corresponding proportion were 50%, 34% and 17% for the United States. Adamchak and Friedmann (1983) projected - assuming normal retirement to remain at age 65 – that youth dependency would decline gradually while working-age dependency would decrease much faster. However, elderly dependency would first increase and then decline slightly. By 2050, the respective shares of youth, working-age adults and elderly would be 52%, 12% and 36%.

One of the primary concerns of this paper are the relationships among the different measures of dependency. As shown in Table 1, there was a relatively constant relationship between the labor adjusted demographic dependency ratio and the CDDR. For example, after 1968, the ratio between the two measures varied within a narrow range, from 2.8 to 3.0. That is, the labor adjusted demographic dependency ratio was about three times that of the CDDR. One reason for the stable relationship between the two measures was that the unemployment rate in Taiwan during this period was relatively constant. By 1995, the male labor-force participation rate had declined slightly, but this was compensated for by the increase in the female labor force participation rate. Consequently, the overall labor-force participation rate has remained rather stable in Taiwan.

V. The Trend of Expenditure Adjusted Dependency Ratios

Schulz, Borowski and Crown (1991) define the expenditure adjusted dependency ratio as:

$$Rt = \frac{(Dta \cdot P1) + (Dtc \cdot P2) + (Dte \cdot P3)}{(Lta \cdot P1) + (Ltc \cdot P2) + (Lte \cdot P3)}$$

where Rt = Expenditure adjusted dependency ratio in year t,
P1 = Per capita expenditures on young persons in year t,
P2 = Per capita expenditures on children in year t,
P3 = Per capita expenditures on elderly persons in year t,
Dta = The number of young adults not in the labor force in year t,
Dtc = The number of children not in the labor force in year t,
Dte = The number of elderly not in the labor force in year t,
Lta = The size of the young-adult labor force in year t,
Ltc = The size of the child labor force in year t,
Lte = The size of the elderly labor force in year t.

Per capita expenditures are taken as weights to calculate the expenditure adjusted dependency ratios. These weights may affect the ratios if expenditure differentials among the age groups are significant and if amounts of expenditure are not too small relative to population size.

Table 2 shows the per capita expenditures - estimated using data from Household Income Surveys—for three age groups from 1976 to 1995. The method of estimation is described in the Data and Method section and in Appendix A. Over the last two decades, per capita expenditures have changed substantially, perhaps resulting from the effect of economic development on traditional values. Traditionally, in Chinese society the elderly are respected for their contribution to the family and children are valued as the future of the family. During hard times, the adults will increase their savings to take good care of their elderly and children. When good times return, the adults and children may spend more. However, the elderly usually remain thrifty to prepare for future downturns.

By 1976, Taiwan's economy had improved for more than two decades. Per capita income in Taiwan increased from US$186 in 1952 to US$1041 in 1976. Taiwan's rapid economic growth has continued, with per capita income growing from $6,889 in 1989 to US$ 12,439 in 1995.

So in 1976, total per capita expenditures amounted to around US$473 for the three age groups (see Table 2). Adults' expenditures were higher than those of the other two groups because of work-related spending. The per capita expenditures of the elderly

and children were 98.8% and 95.9% those of the adults respectively. However, beginning in 1977, children become the major consumers in the household, followed by adults and the elderly. Using 1977 as a base, children-related expenditures increased 8.1 times over the next 18 years, while adult and elderly expenditures increased 7.5 and 6.8 times, respectively, during the same period. Thus, Taiwan's expenditures for all groups grew rapidly along with the economy's fast economic growth but children-related expenditures later exceeded the expenditures of the other two groups. In 1995, children spent 13.7% and 26.6% more than young adults and the elderly, respectively.

Changes in Taiwan's dependent groups have narrowed the gap between young and elderly dependents but the gap still remains substantial. Over the past two decades, the number of children has decreased by 11.6%, from 5.7 million in 1976 to 5.5 million in 1995 (see Table 3). During this period, the number of elderly has risen by 163%, from 0.6 million to 1.5 million. These contrasting changes have slightly improved the uneven distribution of age groups. In 1976, the respective proportions of children, young adults and the elderly were 55.9%, 43.5% and 5.5%, respectively. In 1995, the corresponding proportions were 41.8%, 46% and 12.1%. Despite the rapid increase in the number of elderly, children and young adults remain society's two major groups, still outnumbering the elderly by 3.4 times and 3.8 times, respectively. Thus, an analogous change in the expenditures of either of these groups has a much greater impact on the expenditure-adjusted dependency ratio than a change in expenditures by the elderly.

Taiwan's labor force has increased substantially over the past two decades, but its distribution has changed only slightly. In 1976, there were 5.7 million young adult workers and 40,000 elderly workers (see Table 4). By 1995, the number of young adult workers had risen to 9.0 million while the number of elderly workers had grown to 156,000. Thus, from 1976 to 1995, young adult workers and elderly workers grew by 1.6 and 3.9 times, respectively. Although the number of elderly workers grew faster than that of the young adult workers, its share of the labor force was still negligible, increasing from 0.7% to 1.7% in two decades. Young adult workers, with 95.9%, dominate the labor force.

This analysis has revealed the following: Expenditures as weights are much smaller than major population components in terms of size, and differences in expenditure are

limited relative to population size. The net result of these differences lead to the expectation that the relative values of the expenditure-adjusted dependency ratios to labor force dependency ratios will have remained relatively constant.

Table 5 shows the expenditure-adjusted dependency ratios (LEADDR) and their relationship with the labor force dependency ratios and demographic dependency ratios. LEADDR declined from 1.817 in 1976 to 1.372 in 1995. This declining trend is similar to the trends of the other two measures, and so the relative values of LEADDR to the other two ratios are stable and relatively constant. For example, between 1976 and 1995, the ratio of the LADDR to the LEADDR increased from 0.977 to 1.042, a 6.5% change in 20 years, but with no discernible trend. In fact, from 1977 to 1995, the total increase was only 1.1%, or an average of 0.05%/year, which was well within possible statistical errors.

The relative values of the LEADDR to the Crude Demographic Dependency Ratios range from 2.80 to 3.02, a total variation of 7% over 20 years or an average of 0.35%/year, again with no discernible pattern or trend. Over this twenty year period, the largest difference between these dependency measures is only 5.6%, with the change from 1976 to 1995 being only 2.3%, an average of 0.12%/year. Thus, there is a relatively constant relationship between the expenditure-adjusted dependency ratio and the crude demographic dependency ratio (see Figure 3). The former measure is about 2.8 to 3 times greater than the latter measure.

VI. Summary and Discussion

This paper analyzes the trends of three dependency measures in Taiwan to observe their relationships and to contemplate their economic implications. It was found that Taiwan's population is aging much faster than that of the United States, and the shift from more young and less elderly to less young and more elderly dependents will accelerate in the near future. By the year 2025, elderly dependency will begin to exceed youth dependency.

Of the relationships among the three measures of dependency, it was found that there were no significant differences between the labor-force-participation adjusted dependency ratio (LADDR) and the labor force and expenditure adjusted dependency

ratio (LEADDR) in Taiwan over the past two decades. We also found that both LEADDR and LADDR were about three times as large as the crude demographic dependency ratio (CDDR). These findings may be useful for many of the mature or emerging NICs whose development experiences are similar to those of Taiwan, the implication being that, should they lack expenditure survey data, these other economies could rely on LADDR as a good indicator of the social burden. Whether Taiwan's constant and stable relationship between LADDR and CDDR is due to Taiwan's specific conditions or whether there is a systematic functional relationship between LADDR and CDDR is an issue that needs further study.

Changes in population composition and expenditure in Taiwan also have a fundamental economic implication. They imply that Taiwan's family burden in the past two decades has been gradually eased because the high consumption group decreased in size while the low consumption group increased. The family burden will be further eased when old dependency exceeds young dependency beginning in 2025 as projected by CEPD, ceteris paribus.

Taiwan's family burden can be further eased by two public policies, i.e. national health insurance and a national pension system. Both of them can shift family costs from the private sector to the public sector. However, we must be cautious about their side effects as discussed in the relevant literature. For example, when a national health insurance program is implemented, the public sector may pay more than the private sector had paid before because of the moral hazard problem. The cost to the public sector is further increased because of the increase in the number of the elderly due to population aging. On the other hand, if a national pension system is extended to cover all people aged 65 and over, three issues deserve our concern. One is that the substitution effect caused by the elderly expenditures may disappear. So families may not save as much as they gain from the pension system. In addition, the high saving rates that Taiwan has had may decline sharply as the pension system replaces private savings in providing for old-age security. Finally, the pension system may also encourage more people to retire at an earlier age.

It has been argued that "relatively small increases in economic growth rates have the potential to substantially moderate the ill effects of other factors that have a negative

impact" (Schulz, Borowski and Crown 1991, p108). However, public policies associated with population aging may, ceteris paribus, impede economic growth. So we may face the problem that is analogous to the "chicken and egg problem". We can't be sure about economic growth. Population aging will definitely accelerate in the near future. If we wish to rely on economic growth to release us from the social burden caused by population aging, we must be cautious regarding the introduction of public policies associated with population aging.

References

Adamchak, D. J. and E. A. Friedmann

1983 "Societal Aging and Generational Dependency Relationships — Problems of Measurements and Conceptualization." *Research on Aging*, 5 (3): 319-338.

Chen, C.

1996 "Living Apart from One's Children in Later Life — The Case of Taiwan." *Taiwanese Journal of Sociology*, 19 : 57-93.

Chen K. J., H. H. Winsborough and M. L. Lee

1986 "Population Cycle and Population Control in the Taiwan Area." Pp. 109-132 in H. Y. Chiu and Y. H. Chang (eds.,) *Social and Cultural Change in Taiwan*, Institute of Ethnology, Academia Sinica.

Clark, R. L. and J. J. Spengler

1978 "Changing Demography and Dependency Costs: The Implications of Future Dependency Ratios and Their Composition." Pp. 55-89 in B. R. Herzog (eds.,) *Aging and Income — Programs and Prospects for the Elderly*. Human Science Press.

Coale, A. J.

1972 "Alternative Paths to a Stationary Population." Pp. 589-603 in C. F. Westoff and R. Parke, Jr., (eds.,) *Demographic and Social Aspects of Population Growth*. Washington, D.C.: Commission on Population Growth and the American Future.

Coale, A. J. and Paul Demeny

1966 *Regional Model Life Tables and Stable Population*. Princeton, NJ: Princeton

University Press.

Council for Economic Planning and Development (CEPD)

1996 *Projections of the Population of the Taiwan Area.* Republic of China. Manpower Planning Department, CEPD, Executive Yuan, ROC.

Directorate-General of Budget, Accounting and Statistics (DGBAS)

1996 *Year Book of Manpower Survey Statistics.* Taiwan Area, Republic of China, 1996, DGBAS, Executive Yuan, ROC.

Directorate-General of Budget, Accounting and Statistics (DGBAS)

1996 *Report on the Survey of Family Income and Expenditure in the Taiwan Area of the Republic of China.* 1995, DGBAS, Executive Yuan, ROC.

Fullerton, H. N., Jr.

1980 "The 1995 Labor Force: A First Look." *Monthly Labor Review* (December) :11-21.

Keyfitz, Nathan

1968 *Introduction to the Mathematics of Population.* Reading. Mass.: Addison-Wesley.

Ministry of Interior (MOI)

1996 *1995 Taiwan - Fukien Demographic Fact Book.* Republic of China.

President's Commission on Pension Policy

1980 *Working paper, Demographic Shifts and Projections: Implications for the Pension System.* Washington DC: Government Printing Office.

Preston, Samuel H., N. Keyfitz and R. Schoen

1972 *Causes of Death: Life Tables for National Population.* New York: Seminar Press.

Sheppard, H.L. and S. Rix

1977 *The Graying of Working America: The Coming Crisis of Retirement — Age Policy.* New York: Macmillan.

Shulz H., Allan Borowski and William H. Crown

1991 "Chapter 4: Estimating the Economic Burden of the Aged in the United States." *In Economics of Population Aging,* Auburn House.

United Nations

1956 *The Aging of Population and the Economic and Social Implications*. New York: United Nations.

United Nations

1968 *The Concept of a Stable Population*. New York: United Nations.

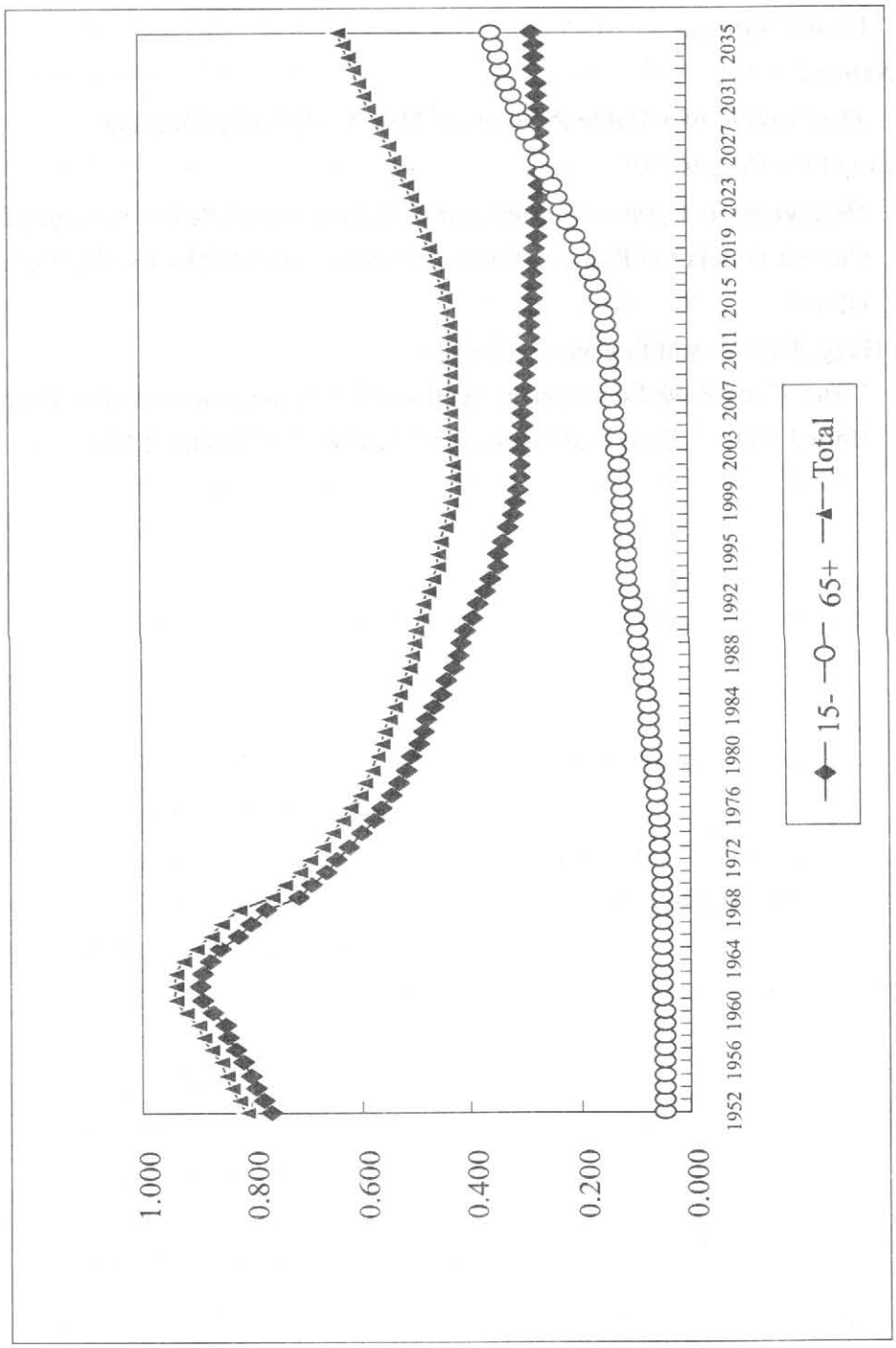
US Bureau of the Census

1975 *Demographic Aspects of Aging and the Older Population in the United States.* Current Population Reports: Special Studies, Series P-23, No. 59, Washington: US.G.P.

Van der Gagg, Jacques and Eugene Smolensky

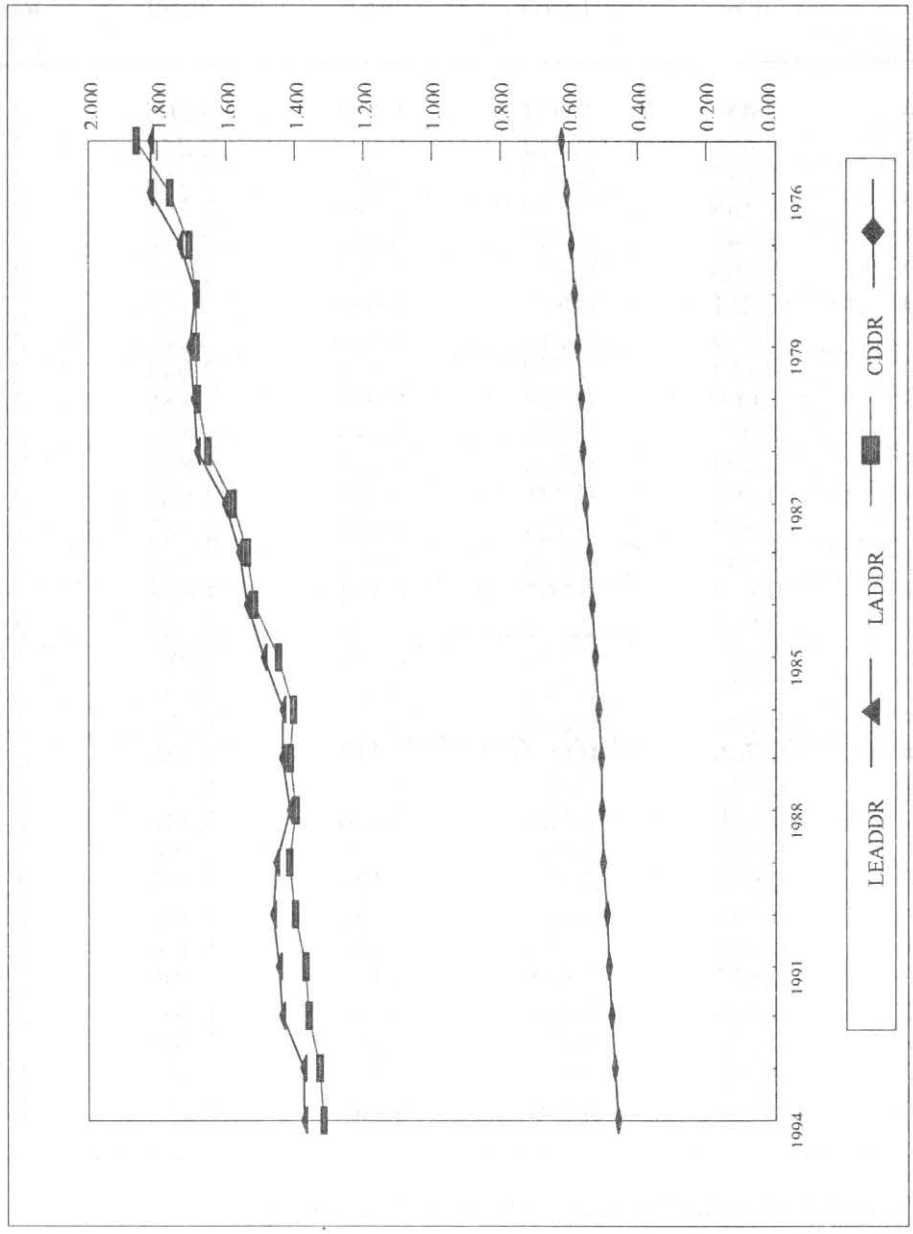
1982 "True Household Equivalence Scales and Characteristics of the Poor in the United States." *Review of Income and Wealth*, 28 (March): 17-28.

Figure 1: Crude Demographic Dependency Ratios, Taiwan, 1952-2035



Source: 1. Taiwan-Fukien Demographic Fact Book, 1959, 1962-1995, MOI
2. Projections of the Population of the Taiwan Area, ROC, CEPD,1996

Figure 2: CDDR, LADDR, LEADDR, Taiwan, 1976-1995



Source: 1. See footnotes of Figure 1

2. LEADDRs are calculated from Family Income and Expenditures surveys, DGBAS

Table 1 : Labor Force Dependency Ratios by Age Groups, Taiwan

Year	15-	15-64	65+	Total	Ratio to CDDR*
1964	1.457	0.674	0.074	2.205	2.380
1965	1.456	0.712	0.077	2.245	2.482
1966	1.437	0.750	0.081	2.268	2.589
1967	1.388	0.739	0.080	2.208	2.581
1968	1.348	0.747	0.081	2.176	2.638
1969	1.298	0.825	0.082	2.204	2.886
1970	1.251	0.817	0.086	2.153	2.902
1971	1.205	0.818	0.089	2.111	2.952
1972	1.154	0.799	0.091	2.044	2.930
1973	1.069	0.728	0.088	1.885	2.792
1974	1.029	0.726	0.090	1.845	2.815
1975	1.009	0.754	0.093	1.855	2.926
1976	0.992	0.771	0.097	1.860	2.996
1977	0.937	0.728	0.097	1.762	2.912
1978	0.900	0.708	0.098	1.706	2.880
1979	0.878	0.707	0.101	1.686	2.896
1980	0.862	0.718	0.105	1.686	2.945
1981	0.847	0.726	0.108	1.681	2.989
1982	0.828	0.714	0.111	1.652	2.963
1983	0.794	0.674	0.110	1.578	2.867
1984	0.766	0.660	0.112	1.538	2.856
1985	0.744	0.657	0.115	1.517	2.855
1986	0.710	0.623	0.116	1.448	2.774
1987	0.682	0.602	0.119	1.404	2.738
1988	0.674	0.614	0.125	1.413	2.793
1989	0.659	0.610	0.128	1.397	2.772
1990	0.654	0.626	0.136	1.416	2.837
1991	0.632	0.626	0.141	1.399	2.866
1992	0.610	0.612	0.146	1.368	2.827
1993	0.593	0.615	0.151	1.360	2.864
1994	0.568	0.604	0.155	1.327	2.845
1995	0.550	0.604	0.164	1.317	2.878

Source : Year Book of Manpower Survey Statistics, 1996. DGBAS.
* CDDR : Crude Demographic Dependency Ratio.

Table 2: Per Capita Expenditures by Age Groups, 1976-1995

(US dollars)

Year	15 - 64		0 - 14		65+	
	Expen.	Index	Expen.	Index	Expen.	Inde
1976	493.921	94.2	473.737	85.3	487.895	92.5
1977	523.395	100.0	555.368	100.0	521.605	100.0
1978	643.789	119.6	680.947	119.2	600.271	111.9
1979	866.333	156.8	901.083	153.7	740.417	134.5
1980	1064.111	192.6	1121.611	191.3	982.278	178.4
1981	1164.773	215.4	1220.767	212.8	1017.967	188.9
1982	1162.474	228.6	1232.209	228.4	1153.246	227.6
1983	1231.078	248.0	1297.678	246.3	1140.315	230.5
1984	1352.473	269.4	1426.047	267.7	1267.945	253.4
1985	1373.281	275.2	1449.348	273.7	1243.502	250.1
1986	1529.406	291.0	1639.313	294.0	1450.304	276.9
1987	1975.212	316.5	2125.667	321.0	1703.703	273.9
1988	2497.274	359.2	2676.057	362.8	2152.289	310.6
1989	3062.287	406.6	3289.322	411.6	2320.106	309.1
1990	3313.574	448.0	3640.238	463.8	2753.812	373.6
1991	3702.871	499.3	4201.342	533.9	3100.559	419.5
1992	4298.172	543.7	4972.695	592.8	3688.792	468.2
1993	4653.732	617.5	5400.531	675.3	4030.201	536.6
1994	5166.553	687.3	5814.286	720.9	4349.471	580.6
1995	5679.464	756.4	6455.228	810.2	5099.622	681.5

Source : Calculated from data of scheduled Family Income and Expenditure Surveys conducted by DGBAS.

Table 3: The Growth of Dependents, 1976 - 1995

Year	Children		Young Adults		Elderly	
	Number	Index	Number	Index	Number	Index
1976	5723	100.0	4452	100.0	559	100.0
1977	5705	99.7	4429	99.5	591	105.6
1978	6190	99.6	3851	100.8	601	110.7
1979	6215	99.8	3945	103.3	639	117.9
1980	6264	99.8	4069	107.0	679	125.0
1981	6276	100.1	4217	110.3	718	130.9
1982	6280	100.7	4315	111.5	738	137.6
1983	6340	100.8	4238	110.0	758	142.9
1984	6321	100.2	4247	111.0	806	150.6
1985	6272	99.5	4356	113.0	852	157.6
1986	6202	98.5	4317	111.1	897	164.8
1987	6127	97.6	4302	110.7	946	174.8
1988	6085	97.2	4440	113.7	1009	185.0
1989	6053	96.6	4515	114.9	1051	192.5
1990	6014	96.3	4693	118.6	1104	204.8
1991	5960	94.6	4756	120.5	1170	216.8
1992	5881	93.4	4772	120.4	1234	228.8
1993	5754	92.0	4908	122.6	1304	240.4
1994	5636	90.2	4949	123.1	1373	252.2
1995	5530	88.4	5041	125.0	1473	263.0

Source : See footnote for Table 1.

Table 4: Changes in the Labor Force, 1976-1995

	Younger Adults		Elderly	
Year	Number	Index	Number	Index
1976	5734	100.0	40	100.0
1977	6036	105.3	52	130.0
1978	6269	109.3	63	157.5
1979	6443	112.4	65	162.5
1980	6567	114.5	63	157.5
1981	6696	116.8	67	167.5
1982	6891	120.2	69	172.5
1983	7191	125.4	76	190.0
1984	7411	129.2	80	200.0
1985	7560	131.8	92	230.0
1986	7841	136.7	106	265.0
1987	8072	140.8	112	280.0
1988	8139	141.9	108	270.0
1989	8268	144.2	121	302.5
1990	8302	144.8	120	300.0
1991	8441	147.2	129	322.5
1992	8633	150.6	132	330.0
1993	8733	152.3	142	355.0
1994	8932	155.8	147	367.5
1995	9053	157.9	156	390.0

Source : See footnote for Table 1.

Table 5: Labor Expenditure Adjusted Dependency Ratios, 1976-1995

Year	LEADDR	LEADDR /LADDR	LEADDR /CDDR
1976	1.817	.98	2.93
1977	1.818	1.03	3.00
1978	1.732	1.02	2.93
1979	1.688	1.00	2.90
1980	1.705	1.01	2.98
1981	1.691	1.01	3.00
1982	1.682	1.02	3.01
1983	1.601	1.01	2.91
1984	1.559	1.01	2.90
1985	1.537	1.01	2.89
1986	1.488	1.00	2.85
1987	1.434	1.02	2.80
1988	1.437	1.02	2.84
1989	1.413	1.01	2.80
1990	1.454	1.03	2.91
1991	1.462	1.04	3.00
1992	1.445	1.06	2.99
1993	1.436	1.06	3.02
1994	1.375	1.04	2.95
1995	1.372	1.04	3.00

Source : Calculated from data shown in Tables 2 - 4.

Appendix A

Estimation of Per Capita Expenditures by Age of Consumer in Households with Children

1. $$\frac{\hat{Total\ EXP}}{FAMSIZE} = A + B * AGE\,HEAD - C * CHILDREN + D * URBAN + E * ED\,HEAD + F * INCOME - G * WIFEEDU$$

2. $$FAMSIZE = CHILDREN + ADULTS$$

3. $$\hat{Total\ EXP} = [A + B * AGE\,HEAD - C * CHILDREN + D * URBAN + E * ED\,HEAD + F * INCOME - G * WIFE{*}EDU] * [CHILDREN + ADULTS]$$

4. $$\hat{ADULT\ EXP} = [A + B * AGE\,HEAD + C * URBAN + D * ED\,HEAD + E * INCOME - F * WIFE{*}EDU] * [ADULTS]$$

5. $$\hat{CHILD\ EXP} = \hat{TOTAL\ EXP} - \hat{ADULT\ EXP}$$

6. $$CHILD\,TOT = \hat{CHILD\ EXP} + CHILD\,TAB$$

Notes:

(1) $\hat{Total\ EXP}$ indicates estimated average total expenditure.
(2) *FAMSIZE* indicates family size.
(3) $\hat{ADULT\ EXP}$ indicates estimated average expenditure by adults.
(4) $\hat{CHILD\ EXP}$ indicates estimated average expenditure by children.
(5) *CHILD TAB* indicates children's tabulated expenditure.
(6) *CHILD TOT* indicates children's total expenditure.
(7) *ED or EDU* indicates education level.

Appendix B

(1) Regression Estimates of Adjusted Quarterly Per Capita Household Expenditures for Younger Families with Children Based on Equation (1) of Appendix A

Independent Variable	Coefficient	t-statistic
INTERCEP	11415.00	20.82
CHILDREN (Number of children)	-2564.07	-41.38
AGE HEAD (Age of head)	-16.91	-1.73
ED HEAD (Education of head)	264.78	9.75
INCOME (Household income)	0.07	50.36
WIFE EDU (Wife's education)	324.17	10.65
URBAN (Lives in urban area (Dummy))	2807.07	14.56
R-square	0.48	

(2) Summary of Statistics for independent variable

Variable	Mean	Std Deviation
Number of children	2.20	1.50
Age of head	42.25	10.19
Education of head	7.90	4.27
Household income	119232.80	67250.85
Wife's education	5.54	4.01
Lives in urban area (Dummy)	0.45	0.50