

**Population Aging and Industrial Competitiveness: The Case of the Electronics  
Industry in Taiwan**

San, Gee  
Graduate Institute of Industrial Economics,  
National Central University,  
Taiwan

Liu, Meng-Chun\*  
Chung-hua Institution for Economic Research,  
Taiwan

Paper to be presented at  
19th Annual East Asian Seminar on Economics  
The Demographic Transition in the Pacific Rim  
June 19-21, 2007, Seoul, Korea.

---

\* Corresponding author, mailing address: 75 Chang-Hsing Street, Taipei, Taiwan. E-Mail: liu@mail.cier.edu.tw.

# **Population Aging and Industrial Competitiveness: The Case of the Electronics Industry in Taiwan**

## **Abstract**

This study finds that, of the electronics firms in Taiwan surveyed, 64% of them agree that the aging problem in Taiwan will have an adverse impact on Taiwan's electronics industry, while only 35% of the firms surveyed do not agree that it will have such an impact. Our study finds that the possible reasons for the aging problem having such an adverse impact are the inevitable difficulties faced in recruiting skilled manpower together with the outward relocation of electronics firms in Taiwan. In addition, this study also finds that policies such as the relaxation of the relevant labor laws which enable part-time workers to participate more actively in the labor force, as well as relevant child-care policies which enable female workers to participate more in Taiwan's labor market are some of the policies that the government may consider implementing so as to reduce the possible adverse impact of the aging problem on the electronics industry in Taiwan.

Keywords: aging, electronics industry, R&D, manpower quality

**JEL:**

## 1. Introduction

Taiwanese statistics indicate that, since September 1993, senior citizens aged 65 and over have accounted for more than 7 percent of the overall population in Taiwan and, based on the UN's standard, Taiwan can be regarded as an aging society. In fact, from Figure 1 it can be seen that the above ratios have exceeded 9 percent since 2003 and, as such, Taiwan's aging problem is surely becoming more pronounced. Along with the problem of aging in Taiwan, Taiwan's fertility rates are also experiencing a rapidly declining trend. From Figure 2 it can be seen that the birth rate declined from 1.518 percent in 1996 to 1.006 percent in 2003. Clearly, the Taiwan economy is experiencing rapid-aging as well as low-fertility (RALF). As such, various related problems arise. For instance, under a RALF economy, how will such an aging labor force affect the competitiveness of Taiwan's industries? In addition, under such circumstances, what are the possible policy options for both enterprises and policy-makers?

In this paper, we shall focus on the issue of how aging impacts industrial competitiveness in Taiwan and we shall utilize Taiwan's electronics industry as an example to examine such an important issue. It is important to note that, since Taiwan is a RALF society, aging may have two contrasting impacts on its industrial competitiveness. On the one hand, it may actually improve the quality of the labor force since families can devote more educational resources to their children and the quality of the labor force will, therefore, be improved. Under such circumstances, the aging and low fertility phenomenon may actually *enhance* the competitiveness of the industry. On the other hand, however, it could be argued that the aging of the labor force may actually hinder the industry's ability to adopt the new technology as well as its corresponding innovative capability and, as such, the aging of the labor force will adversely affect the competitiveness of the industry. To explicitly examine such an important question, in this study we have conducted a large-scale survey of all the major listed electronics firms in Taiwan and have asked firms to evaluate the above two contrasting possibilities. Our survey shows that more than 64 percent of the responding firms considered that the aging of the population in Taiwan will have had a significant adverse impact on their operations in Taiwan and their main concern is that the aging of the labor force will undermine their ability to recruit skilled labor in Taiwan and, as a result, the firms will be forced to speed up their outward investment toward other countries.

(Insert Figures 1 and 2 around here.)

The discussion of the relevant issues highlighted above will proceed as follows. In Section 2 of the paper, we will examine some descriptive statistics to show how serious the aging of the

labor force problem in Taiwan really is, and then in Section 3 we will examine the questionnaire survey results in order to gain an in-depth understanding as to the possible impact of the aging work force on the listed electronics firms in Taiwan. In Section 4 of this paper, we will go a step further and utilize relevant regression models to examine the possible policy options that the government may consider so as to mitigate its possibly adverse impact of the aging of the population. We will then summarize our main findings and conclusions in Section 5.

## **2. The Aging of the Labor Force in Taiwan**

We begin our analysis by examining the aging problem associated with the labor force in Taiwan. In Table 1, we calculate the ratios for those employed workers aged 45 to 64 as well as for those employed workers aged 45 and above to total employed workers in Taiwan, respectively. Such statistics can provide us with a simple but clear measurement as to how serious the aging problem really is in Taiwan. From the Table it can be shown that over the period 1980-2005, the ratios for those employed workers aged 45 to 64 (variable V1) decreased from 24.35 percent in 1980 to 23.01 percent in 1995 and then increased steadily to 30.23 percent in 2005. By examining the ratios for those employed workers aged 45 and above (variable V2), Table 1 also shows that in 2005 the corresponding ratio reached 31.80 percent. In addition, from Table 1, which also includes the ratios of employed workers with a college or above education to total employed workers in Taiwan (variable V3), the relevant statistics show that the ratio has increased rapidly over the years. Clearly, the coexistence of rapid aging and a substantial improvement in labor quality are the two distinctive phenomena for the employed workers in Taiwan. In Figure 3, we also show the change in the time trends for variables V1-V3.

(Insert Table 1 and Figure 3 around here.)

As for employed workers in the manufacturing sector, in Table 2 we have summarized the relevant statistics for the ratios of workers in different age groups related to total employed workers in the manufacturing sector. From the Table it is shown that the ratio of workers aged 45 and above to total employed workers in the manufacturing sector (variable V2M) increased from 13.50 percent in 1985 to 25.43 percent in 2005. The population aging effect can also be found in the manufacturing sector in Taiwan, and such an aging trend can also be observed by examining Figure 4.

(Insert Table 2 and Figure 4 around here.)

The population aging problem can also be gauged from another perspective, namely, from the ratios of skilled (blue collar) workers aged 45 and above to total employed workers, for which the corresponding ratio is V4 (V5). More specifically, in this study we define skilled workers as professionals, technicians and assistant professionals. All of these workers will be included in calculating the ratio V4. Similarly, blue collar workers include production workers, operators and unskilled labor when we calculate the ratio V5. From Table 3 it is shown that for skilled employed workers, the ratio V4 decreased from 22.43 percent in 1980 to 16.60 percent in 1995 and rose to 21.93 percent in 2005. In fact, the ratio in 2005 is very close to its highest level in the 1980s. Clearly, the population aging problem can also be verified among the skilled manpower in Taiwan. In fact, the aging problem for the unskilled workers' group is even worse. From Table 3 it can be shown that the ratio V5 rose steadily and rapidly from 14.95 percent in 1980 to 33.84 percent in 2005. The corresponding trend can also be shown in Figure 5.

(Insert Table 3 and Figure 5 around here.)

By comparing all the relevant statistics in Tables 1, 2 and 3, we can summarize the aging problems in Taiwan as follows. First, generally speaking, the employed workers aged 45 and above still account for an increasing share of the total employed workers in Taiwan and this may be due to the fact that the number of unskilled workers aged 45 and above is increasing more rapidly than all the other groups of workers in their corresponding occupations. Second, as for professional and skilled workers, the relevant statistics show that their corresponding shares have increased, which is really due to a rapid improvement in higher education in Taiwan. Nevertheless, the aging trend for the population as a whole also adversely affects workers in this professional group. As such, we observe the coexistence of the improvement in the labor force on the one hand and the aging of the skilled professionals on the other. Thirdly, the number of employed workers aged 45 and above in the manufacturing sector has increased steadily and rapidly since 1985, which clearly suggests that the aging phenomenon can affect all professions and all industries, this case of manufacturing that we have discussed above being merely one of the examples. In light of the emerging aging problem in Taiwan, in the following section, we shall utilize a large scale survey for all the relevant listed electronics firms in Taiwan to examine the possible impacts that such an aging problem might have on their operations in Taiwan. Furthermore, we also consider the business strategies that these firms might adopt as well as the policies that the government might consider in order to

cope with such an alarming trend in Taiwan.

### **3. Survey Results for Listed Electronics Firms in Taiwan**

To examine the possible impact of population aging on industrial development in Taiwan, in this section of the paper, we shall use the electronics industry as an example to perform the evaluation. There are two main reasons for choosing the electronics industry as the focus of our study. First, the industry accounts for more than 20 percent of the total value added of the manufacturing sector in Taiwan and it is one of the most important industries in Taiwan. Secondly, the rate of technological change in this industry has been accelerating so rapidly that the electronics industry is indeed an important and typical sector for examining how the aging of the work force will affect this and similar kinds of industries in Taiwan.

To explore such an important issue, in this study we surveyed all the listed 839 electronics firms in Taiwan in 2005 in order to address the following two main questions. First, how will the workforce aging problem affect the surveyed firm's hiring and recruiting? In order to explicitly examine such an important question, in this survey we have decomposed the workers into 7 types, namely, laborers, skilled laborers, engineers, R&D personnel, administrative personnel, managers, and high-level managers. In addition, each of the surveyed firms was asked about its evaluation of the difficulties that might be faced in recruiting the above seven different types of personnel over the next ten years, and that if such difficulties were to exist, how the firms would respond to them.

Secondly, in terms of enterprise R&D and innovation, in this study we also addressed the following important questions: (1) Is it possible that the quality of education may actually be raised due to a steady decline in the birth rate and, if so, can the possibly adverse effect of the population aging trend be offset by a improvement in the quality of the population. (2) Will such an aging trend hinder the overall long-term development of the electronics firms surveyed in Taiwan, and what are the strategies that they might adopt to deal with such a trend? In addition, from the point of view of the electronics firms, what are the possible policy options that the government can consider to effectively respond to such an inevitable aging trend?

In our survey, we did not ask the electronics firms for financial data related to their annual sales value, R&D expenditure, salary payments, total number of employed workers or their outward investment arrangements, since all such information is available from their annual

financial reports that have been verified by certified accountants<sup>1</sup>. Our survey covered the period from March 2006 to September in that same year. We were able to collect 152 returned surveys, reflecting a response rate of about 18.12 percent. It is important to note that, even though the response rate was not as high as what we expected, the 152 surveys returned accounted for 34.02 (28.14) percent of the total sales (total number of workers) of listed electronics firms in Taiwan. The corresponding statistics can be seen in Table 4.

(Insert Table 4 around here.)

In this section of the paper we summarize our descriptive surveyed statistics as follows. As for the difficulties that might be encountered in recruiting the 7 different types of workers that we mentioned above, the corresponding results from the survey are as shown in Table 5. From the Table it is seen that the listed electronics firms in Taiwan face difficulties recruiting high-level managers, followed by R&D personnel, engineers, skilled workers, and laborers. Clearly, our survey results show that it is the higher levels of manpower that the surveyed electronics firms in Taiwan are experiencing major difficulties recruiting. In addition, in terms of the problems in recruiting workers that might arise over the next ten years, our survey results as indicated in Table 6 suggest that the high-level managers will still be ranked as the most difficult type of personnel to recruit in Taiwan, followed by R&D personnel and then by pure raw labor. Clearly, the problems associated with a shortage skilled labor will become even worse over the next 10 years. In Table 7, we also summarize the corresponding impacts of shortages of each of the 7 different types of worker, with the results of our survey suggesting that the difficulties faced in recruiting high-level managers will have the most significant impact on the electronics firms surveyed in Taiwan, followed by R&D personnel, engineers, and skilled workers. The shortage of the pure raw labor does not seem to constitute a major concern for the operation of the surveyed firms in Taiwan.

(Insert Tables 5, 6 and 7 around here.)

As to whether or not it is possible that the lower fertility rate in Taiwan may actually lead to more investment in education, which may, in turn, improve the quality of the work force in Taiwan, the results of our survey summarized in Table 8 indicate that 40.13 percent of the respondents agreed that it was ‘likely’, while 11.84 percent of them agreed that it was ‘very likely’. As such, it can be inferred that over 52 percent of the surveyed respondents believed that there was such a possibility. By contrast, the combined sample for those firms that

---

<sup>1</sup> More specifically, these financial data can be downloaded from the Taiwan Economic Journal’s Market Observation Post System.

returned the surveys that believed that there was ‘no chance’ of such a possibility or believed that it was ‘unlikely’ merely accounted for 20 percent. As such, we may conclude that the majority of the electronics firms in Taiwan that returned the surveys agreed that the quality of the labor force would improve despite the fact that the fertility rates are exhibiting a downward trend in Taiwan.

(Insert Table 8 around here.)

It is important to note that while an aging work force may lead to difficulties in recruiting the needed skilled personnel, this phenomenon may also exist if there is an improvement in the quality of the work force as we noted above. As such, the surveyed firms were asked to evaluate the net effect of these two contrasting impacts and how they will affect their R&D and innovation activities in Taiwan. Our survey in relation to this shows that over 37.33 percent of the surveyed and returned sample firms considered that the positive improvement in the work force may outweigh the negative effect arising from difficulties recruiting and that the future trend was still optimistic. Nevertheless, it was still some cause for concern since over 57 percent of the surveys returned indicated that the electronics firms believed that the negative impact would outweigh the positive possibilities and, as such, the aging work force cannot be compensated for by the possible improvement in the quality of the work force in Taiwan.

In our survey, we also asked the surveyed firms to check, in light of the aging work force problem in Taiwan, the possible adverse impacts that such aging may have on their development in Taiwan. Our surveyed results are summarized in Table 9. From the Table it is shown that the difficulties faced in recruiting skilled manpower ranked number one, followed by their forced outward migration to foreign countries, rising production costs, and the adverse effect on their drive to upgrade their technology. As for the possible development trend for the electronics firms in Taiwan, in our survey, we listed 7 possible development trends and the relevant surveyed results are summarized in Table 10. From the Table it is shown that ‘the market demand for senior citizen-related electronic products will become more relevant’ ranked number one, followed by ‘the utilization of Internet- and Wi-Fi-related products will be intensified for the industry’, ‘relevant arrangements for worker’s lifetime learning will be intensified’, ‘more flexibility will be observed for work hours, job assignments and paid vacations among firms in the industry’, ‘there will be an increasing trend towards self-employment in the industry’, ‘job security will be lowered in the future’ and lastly ‘there will be a tendency for the hiring of senior workers in the industry to



increase'. Clearly, the employment of senior workers will still be the major problem facing the aging work force in Taiwan.

(Insert Tables 9 and 10 around here.)

In terms of the strategies that could be adopted to cope with such an aging trend in Taiwan, the results from our survey as shown in Table 11 suggest that the surveyed electronics firms in Taiwan considered that 'enhancing the internationalization of their operations' ranked number one, followed by 'enhancing in-service training', 'enhancing R&D to boost their technological capability', 'enhancing production automation', 'enhancing outward investment toward China', 're-adjusting their internal organizational structure to be able to hire more middle-aged and senior workers' and lastly 'reducing investment in Taiwan'. As for the possible government policy options, our surveyed results are summarized in Table 12 for reference. From the Table, it is shown that 'wage subsidies for firms hiring senior workers' ranked the highest, followed by 'relaxation of the relevant labor laws so as to provide more incentives to hire part-time workers', 'encouraging firms to internationalize their operations', 'subsidies for in-service training expenses', 'providing more comprehensive child-care programs to promote female labor force participation', 'subsidies or rewards to encourage more children to be born' and lastly 'allow more alien workers to work legally in Taiwan'.

(Insert Tables 11 and 12 around here.)

To sum up, our survey for all the listed electronics firms in Taiwan shows that, in light of the aging work force in Taiwan, recruitment for high-level managers, R&D personnel and engineers all encountered the most serious problems among the surveyed electronics firms in Taiwan and that such a problem will still be likely to persist in the foreseeable future. Our survey also shows that the aging problem in Taiwan can not be compensated for by the improvement in the quality of the work force in Taiwan and that it will adversely affect the drive to upgrade technology in Taiwan. Nonetheless, the aging labor force in Taiwan will provide certain business opportunities for the demand for senior citizen-related electronic products in Taiwan will be increased and it may also promote the Internet- and Wi-Fi-related services in Taiwan. Nevertheless, our surveyed results also show that 'the tendency for the senior workers to be hired' is the least likely trend for the electronics firms in Taiwan. To make up for such deficiencies, the results based on the firms surveyed suggest that policies such as wage subsidies for firms that hire senior workers as well as increased flexibility with regard to relevant labor laws so as to encourage firms to hire more part-time workers are

some of the policies that the government might consider.

#### 4. Empirical Analysis

Based on the above survey results, in this section of the paper we explicitly analyze two empirical issues, namely, we first ask, under the RALF situation, what are the relevant factors that may lead a surveyed electronics firm to consider that it can turn the aging and low fertility rates into a favorable factor by engaging in more investment and, subsequently, improving human capital. Secondly, we also examine whether or not the surveyed electronics firms in Taiwan believe that the population aging problem will adversely affect their development in Taiwan. As for the first question, in our survey questionnaire we listed five possibilities the surveyed firms could select from, namely, ‘very likely’, ‘likely’, ‘fair’, ‘unlikely’ and ‘very unlikely’, and the index numbers 4, 3, 2, 1, and 0 are assigned to the above five possibilities, respectively. The corresponding variable will be referred to as the variable LQ. We shall then utilize the Tobit model to analyze the following equation:

$$LQ = \alpha_0 + \alpha_1 X_1 + \alpha_2 X_2 + \alpha_3 X_3 + \alpha_4 X_4 + \varepsilon_i \quad (1)$$

In terms of the second question, an index variable SHOCK will be assigned a value of 1 if the surveyed firm’s assessment is that they will be adversely affected by the aging work force, and 0 otherwise. As such, we will utilize the Probit model to perform the analysis and our empirical model will be specified as:

$$SHOCK = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \varepsilon_j \quad (2)$$

In the above empirical models (1) and (2), the corresponding explanatory variables can be categorized into four sets. The first set of variables,  $X_1$ , is relevant to the characteristics of the firm, and includes years of establishment (AGE), annual sales revenue (SALE), the total number of employees (WORKER), total salary payments (SALARY1), the total salary payments to total sales ratio (SALARY2), total R&D expenditure (RD1), the total R&D expenditure to total sales ratio (RD2), and whether or not the surveyed firm is engaging in outward investment (INVEST1).

The second set of explanatory variables,  $X_2$ , is relevant to the surveyed firm’s assessment of various problems related to aging. More specifically, we include five surveyed questions in our empirical analysis. These concern the expected difficulty in recruiting R&D personnel over the next ten years (RE), whether or not there will be more flexibility in working hours, work assignments and paid vacation for the electronics industry in Taiwan (T1), whether or

not the Internet and Wi-Fi development will speed up (T2), whether or not the surveyed electronics firm will place more emphasis on a worker's lifetime learning (T3), and whether or not, in the future, the number of self-employed workers will increase in the electronics industry in Taiwan (T4). In addition, in both empirical models (1) and (2), we also include a set of possible reaction variables,  $X_3$ , and these include those E1 to E4 variables listed in Table 13. Last but not least, we also include a set of relevant government policy variables,  $X_4$ , which are variables G1 to G7 and they are also listed and explained in Table 13. The corresponding empirical results are summarized in Tables 14 and 15 for models (1) and (2), respectively.

As for the possibility of improving labor quality under an aging society in Taiwan, our empirical Tobit model results in Table 14 show that firms with longer periods of establishment (AGE) or firms with higher R&D expenditure (RD1) and firms engaging in outward investment activities (INVEST1) so as to leverage more foreign resources all confirmed the existence of such possibilities. By contrast, firms with larger annual sales (SALE) or firms with higher shares of labor cost in their sales revenue (SALARY2) confirmed otherwise. In addition, Table 14 also shows that those firms that expect that they will encounter problems in recruiting R&D personnel over the next ten years (variable RE) will be the firms that do not think that such an improvement in labor quality is possible.

As for the relevant future trend variables (T1, T2 and T3), our empirical results indicate that only variable T2 is significant and positive. This clearly suggests that as the utilization of the Internet and Wi-Fi become more popular (T2), the quality of manpower can surely improve despite the trend toward an aging population in Taiwan. As for the relevant strategies that may adversely affect the quality of population, Table 14 shows that, if the survey firms plan to reduce their investment in Taiwan (variable E2), they will be the firms that hold a pessimistic view that the manpower upgrading is less likely to happen in Taiwan. By contrast, if the government provides subsidies to encourage firms to devote themselves to more in-service training (G6), our empirical results show that this can serve as an effective policy tool in upgrading the quality of the manpower in spite of the trend toward an aging population in Taiwan.

(Insert Table 13 around here.)

The empirical results in Table 14 show that factors such as 'firms engage in higher R&D investment input', 'firms engage in outward investment to leverage more foreign resources',

‘the improvement in Internet and Wi-Fi infrastructure’, and ‘government polices to provide in-service training subsidies’ are relevant factors and policies for upgrading the quality of the manpower despite the trend toward an aging population in Taiwan. By contrast, factors such as higher labor costs, encountering R&D personnel recruitment difficulties as well as a reduction in investment in Taiwan are all shown to adversely affect the drive to upgrade the population in Taiwan.

In Table 15 we summarize the empirical findings regarding whether or not the aging of the population may have had an adverse impact on the surveyed firms’ development in Taiwan. Our empirical results suggest that variables such as years of establishment (AGE), annual sales (SALES), the number of employees (WORKER), or R&D inputs (RD1 or RD2) are all shown to have no significant adverse impact on the operations of electronics firms in Taiwan. By contrast, factors such as higher labor costs to total sales (SALARY2) and the surveyed firms that are encountering difficulties in recruiting R&D personnel (RE) are shown to have a significantly adverse impact on the operation of the electronics firms in Taiwan.

Despite the adverse factors mentioned above, Table 15 also shows that factors such as a trend toward more flexibility in work hours, work assignments and paid vacation (T1), an open door policy in regard to the hiring of alien workers (G2), a more flexible labor regulation related to the labor law which can encourage part-time workers to work in the labor market (G3), as well as a more comprehensive policy toward child-care so as to encourage female workers to work more in the labor force (G4) are all shown to have a favorable impact in terms of mitigating the firm’s operating difficulties in Taiwan. As such, our empirical results in Table 15 do shed some light on the policies that could be used to respond to the problem of an aging work force in Taiwan. Among all the possible policies, a more flexible labor market regulation seems to be one of the key and more effective factors coupled with the adverse trend toward the aging of the population in Taiwan.

(Insert Table 15 around here.)

## **5. Conclusion**

In this paper we have examined the problem of population aging in Taiwan and from the government’s related statistics it is observed that the aging problem in Taiwan is becoming more serious and has had three major impacts on the labor market in Taiwan. First, the ratio of workers aged 45 and above relative to the total number of employed workers is still

exhibiting a rising trend. In addition, the ratio of raw labor aged 45 and above relative to all employed workers is rising at an even faster pace. Clearly, the above statistics suggest that it is no longer suitable for those industries that employ huge amounts of raw labor to operate in Taiwan. Secondly, for those skilled workers aged 45 and above, their corresponding ratios are also increasing which clearly suggests that the population is aging on the one hand and the quality of education is improving on the other. As such, whether or not such an improvement in labor quality will be sustainable in the future will become a critical issue for Taiwan in the foreseeable future. Thirdly, as for the manufacturing sector in Taiwan, the ratio of workers aged 45 and above relative to total workers employed in manufacturing has risen steadily since 1985. As such, it can be inferred that the workforce aging problem has profoundly affected all industries and occupations in Taiwan.

In addition, in this paper, we also conducted a large-scale survey of the listed electronics firms in Taiwan. The results of our survey show that it is the high-level managers, R&D personnel and engineers that make up the top three occupational categories that are currently the most difficult to recruit for all of the electronics firms surveyed in Taiwan. In addition, when we look into the future, such recruiting problems will not be alleviated in the next 10 years and, consequently, this will induce more electronics firms to reallocate their operations abroad and such an outward investment trend may become inevitable.

In light of the growing aging problem in Taiwan, our study has also found that there exist three major possible trends for the electronics firms in Taiwan. First, the application of the Internet and Wi-Fi will be speeded up. Secondly, those products that are more suitable to the needs of the senior citizen will be given a higher priority. Thirdly, the life-time learning mechanism will be emphasized in the light of the aging work force in Taiwan. In addition, our study has found that among all of the 7 trends surveyed for the electronics firms in Taiwan, 'willingness to hire middle-aged and senior workers will be higher' ranks the lowest and it is also an alarming signal for the employment market in Taiwan. As such, in terms of the relevant government policy toward an aging work force problem in Taiwan, our study shows that policies to provide subsidies to firms to hire senior workers, the relaxation of relevant labor laws and regulations to allow more job opportunities for part-time workers, the internationalization of the firm's operations to leverage more resources involving foreigners, subsidies for in-service training, and a more comprehensive policy in providing child-care services are all relevant in coping with the aging work force problem in Taiwan.

Last but not least, it should be noted that population and work force aging is an inevitable

trend in Taiwan. In this study we utilize the electronics industry as an example to show that the competitiveness of the industry will be affected primarily due to the difficulties faced by the electronics firms in being unable to recruit their needed higher level managers and R&D personnel. A more intense effort to improve the quality of manpower, subsidies to encourage the hiring of senior managers and in-service training together with an attempt to introduce more flexibility into the labor market seem to be key policy options when seeking to respond to such challenges. As one of the newly-industrializing economies in Asia, Taiwan's aging population experience can serve as a useful source of reference for countries that face similar situations.

## References

1. Ashenfelter, Orley and David Card (2003), "Did the Elimination of Mandatory Retirement Affect Faculty Retirement?" *American Economic Review*, 92, 957-980.
2. Borsch-Supan, Axel (1993), *Aging in Germany and the United States: International Comparisons*, National Bureau of Economic Research Working Paper: 4530.
3. Gillin, C. and T. Klassen (2000), "Retire Mandatory Retirement," *Policy Options*, July-August, 59-62.
4. Hers Diane E. and Philip L. Rones (1989), "Institutional Barriers to Employment of Older Workers," *Monthly Labor Review*, April, pp. 14-21.
5. Hutchens, Robert M. (1987), "A Test of Lazear's Theory of Delayed Payment Contracts," *Journal of Labor Economics*, 15(4), 153-170.
6. Hutchens, Robert M. (1986), "Delayed Payment Contracts and a Firm's Propensity to Hire Older Workers," *Journal of Labor Economics*, 4(4), 439-457.
7. Johnson, Richard (2004), "Economic Policy Implications of World Demographic Change," *Federal Reserve Bank of Kansas City Economic Review*, 89(1), 39-64.
8. Lazear, Edward P (1986), "Retirement from the Labor Force," in *Handbook of Labor Economics*, North-Holland, 305-355.
9. Lazear, Edward P. (1979), "Why is There Mandatory Retirement?" *Journal of Political Economy*, December, 87, 1261-1283.
10. Leigh, Duane (1984), "Why is There Mandatory Retirement? An Empirical Reexamination," *Journal of Human Resources*, 19(4), 512-531.
11. Lumsdaine, Robin L. and Olivia S. Mitchell (1999), "New Developments in the Economic Analysis of Retirement," in *Handbook of Labor Economics*, North-Holland, 3262-3303.
12. McDaniel, Susan A. (2003), "Toward Disentangling Policy Implications of Economic and Demographic Changes in Canada's Aging Population," *Canadian Public Policy*, 29(4), 491-510.
13. Neumark, David (2003), "Age Discrimination Legislation in the United States," *Contemporary Economic Policy*, 21(3), 297-317.
14. Organisation for Economic Co-operation and Development (1998), *Maintaining Prosperity in an Aging Society*, Paris and Washington, D.C.: Author.

15. Shannon, M. and D. Grierson (2004), "Mandatory Retirement and Older Worker Employment," *Canadian Journal of Economics*, 37(3), 528-551.



Figure 1. Aged 65 and over to Total Population Ratios

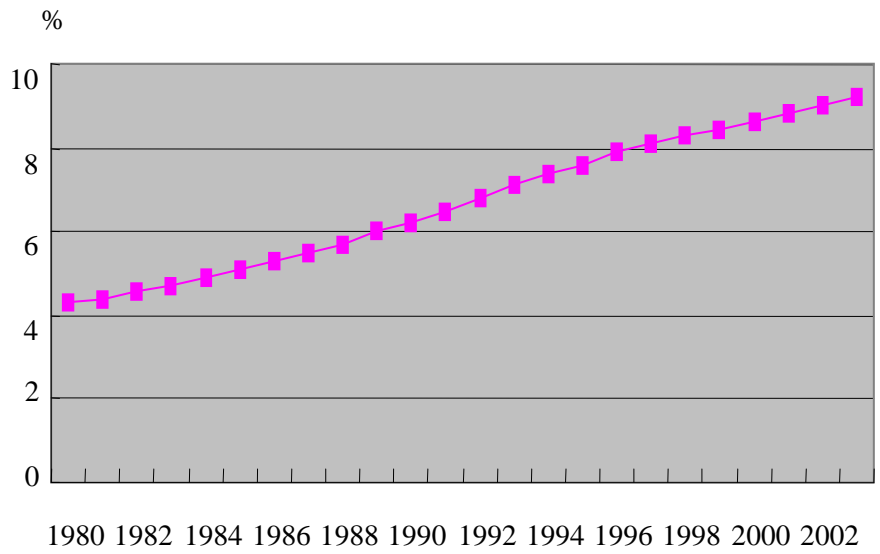


Figure 2. Birth Rates

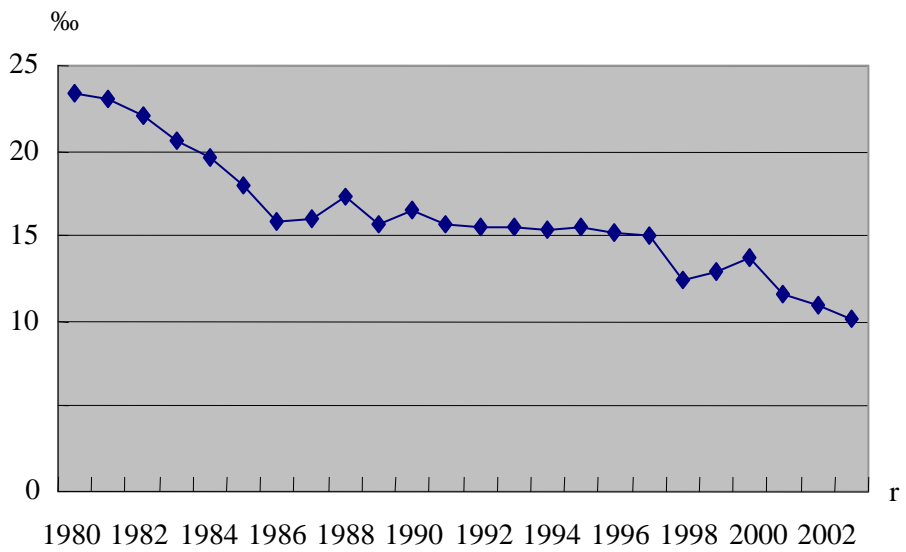


Table 1. Ratios of Employed to Total Employed, by Age and by Education %

Year	V1	V2	V3
1980	24.35	25.31	10.40
1985	23.96	25.20	12.49
1990	23.07	24.52	16.35
1995	23.01	24.73	20.63
2000	26.13	27.66	27.35
2005	30.23	31.80	34.78

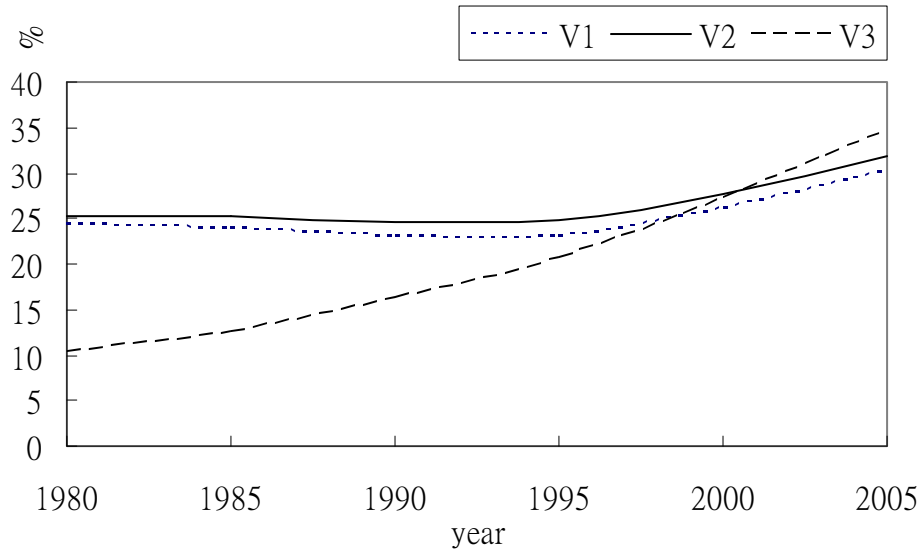
Notes: V1: Ratios of Employed aged 45~64 to Total Employed.

V2: Ratios of Employed aged 45 and above to Total Employed.

V3: Ratios of Employed with College Education to Total Employed.

Sources: Monthly Bulletin of Manpower Statistics, DGBAS, R.O.C. °

Figure 3. Time Trend for V1, V2, and V3



Note: V1: Ratios of Employed aged 45~64 to Total Employed.

V2: Ratios of Employed aged 45 and above to Total Employed.

V3: Ratios of Employed with College Education to Total Employed.

Table 2. Ratios of Employed to Total Employed in Manufacturing Sector, by Age %

Year	V1M	V2M
1980	14.30	14.71
1985	13.05	13.50
1990	15.29	15.82
1995	17.14	17.88
2000	20.52	20.93
2005	25.06	25.43

Notes: V1M: Ratios of Employed aged 45~64 to Total Employed in Manufacturing.

V2M: Ratios of Employed aged 45 and above to Total Employed in Manufacturing.

.Sources: Same as Table 1.

Figure 4. Time Trend for V1M and V2M

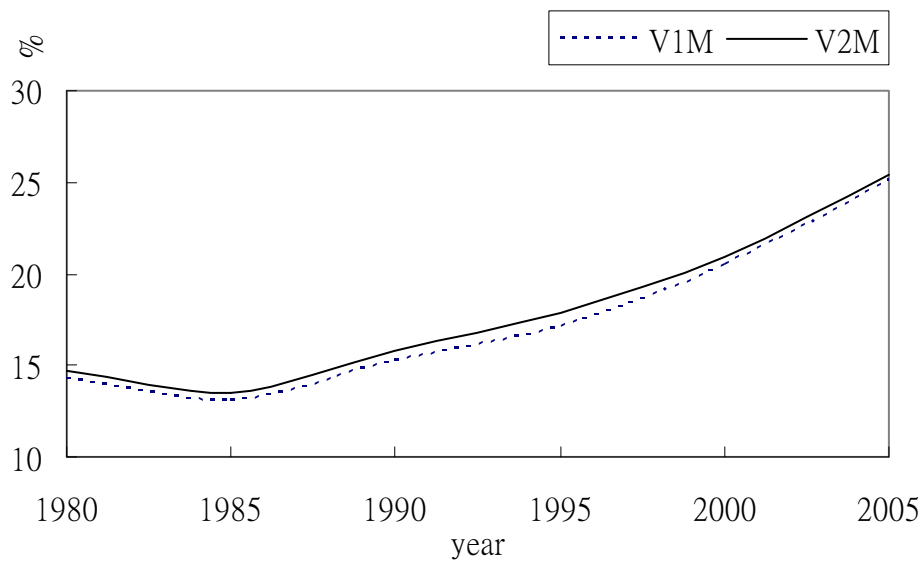


Table 3. Ratios of Skilled and Unskilled Workers Aged 45~65+ to Total Employed

Year	V4	V5
1980	22.43	14.95
1985	23.03	15.28
1990	18.30	18.01
1995	16.60	21.85
2000	19.30	26.60
2005	21.93	33.84

Note 1: V4: Ratios of Skilled Workers (including Professional, Skilled, and Assistant Skilled Workers) aged 45~65+ to Total Employed Workers.

V5: Ratios of Raw Labor aged 45~65+ to Total Employed Workers.

Sources: Same as Table 1.

Figure 5. Time Trend for V4 and V5

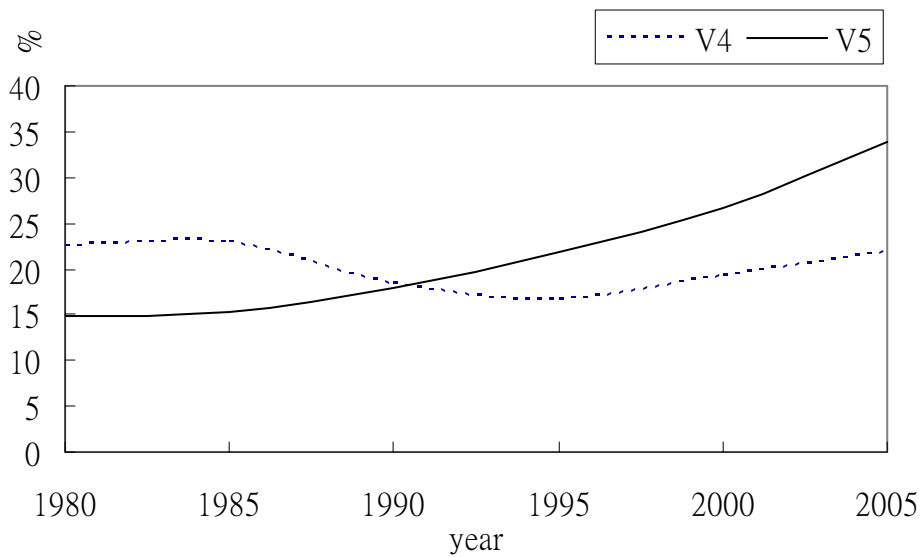


Table 4. Population and the Returned Sample Statistics

	Population (1)	Returned Samples (2)	(2)/(1) %
No. of Firms	839	152	18.12 %
Total Sales (in Million NT\$)	7,697,252	2,618,656	34.02 %
Total Employed Workers (Person)	563767	158650	28.14 %

Source: This study.

Table 5. Difficulties in Recruiting Relevant Workers in Different Professional Groups

No. of Effective Observations: 145

Category Occup.	Easy	Not so Easy	Fair	Difficult	Very Difficult	Weighted Sum	Ranking
Labor	27	35	28	36	12	385	5
Skilled Labor	18	46	43	30	6	389	4
Engineer	11	30	60	38	5	428	3
R&D Personnel	8	19	45	56	15	480	2
Administrative	78	41	24	0	0	232	7
Manager	14	47	56	24	2	382	6
High-level Manager	5	18	40	57	25	514	1

Source: This study.

Note: Points 1, 2, 3, 4, and 5 are assigned respectively to categories 'easy', 'not so easy', 'fair', 'difficult', and 'very difficult'.

Table 6. Difficulties in Recruiting Relevant Workers in Different Professional Groups for the Next 10 Years

No. of Effective Observations: 145

Category Occup.	Easy	Not so Easy	Fair	Difficult	Very Difficult	Weighted Sum	Ranking
Labor	18	23	27	39	31	456	3
Skilled Labor	16	31	40	37	19	441	5
Engineer	8	27	53	48	8	453	4
R&D Personnel	9	22	40	47	23	476	2
Administrative	75	36	31	1	0	244	7
Manager	16	39	55	27	6	397	6
High-Level Manager	6	20	36	59	24	510	1

Source: This study.

Note: The same as Table 5.

Table 7. How will it Affect the Operation of the Business

No. of Effective Observations: 129

Category Occup.	Easy	Not so Easy	Fair	Difficult	Very Difficult	Weighted Sum	Ranking
Labor	24	39	26	19	16	336	6
Skilled Labor	11	28	38	30	20	401	4
Engineer	4	12	33	53	26	469	3
R&D Personnel	4	9	27	49	37	484	2
Administrative	33	45	36	12	1	284	7
Manager	5	30	44	38	10	399	5
High-Level Manager	3	11	29	45	41	497	1

Source: This study.

Note: The same as Table 5.

Table 8. Evaluation of the Possibility of Upgrading Manpower Quality

No. of Effective Observations: 152

Would it be possible that the low fertility rate in Taiwan might actually lead to an improvement in manpower quality since the family can devote more educational resources to their children?	No Chance	Unlikel y	Fair	Likely	Very Likely
No. of Firms	3	28	42	61	18
(%)	1.97	18.42	27.63	40.13	11.84

Source: This Study.

Table 9. Why the Work Force's Emerging Aging Problem may Adversely Affect the Electronics Industry's Development in Taiwan

No. of Effective Observations: 98

Reasons	No. of Firms	(%)	Ranking
It may lead to difficulties in recruiting skilled manpower	61	62.24%	1
It may lead to outward re-location of the firm	54	55.10%	2
It may lead to a higher production cost	37	37.76%	3
It may adversely affect the technology upgrading drive	32	32.65%	4

Table 10. Possible Future Trends for the Electronics Industry in Taiwan

Total Effective Observations: 150

Possible Trends	Very Unlikely	Unlikely	Fair	Likely	Very Likely	Weighted Sum	Ranking
The Market Demand for Senior Citizen-related Electronic Products will become more relevant.	1	12	15	62	59	613	1
The Utilization of Internet- and Wi-Fi-related Products will be Intensified for the Industry.	1	5	40	54	47	582	2
Relevant Arrangements for the Worker's Lifetime Learning will be Intensified.	1	7	33	72	34	572	3
More flexibility will be observed for Work Hours, Job Assignment and Paid Vacations among Firms in the Industry.	5	37	19	65	25	521	4
There will be an Increasing Trend for Self-Employed Workers in the Industry.	7	20	45	62	16	510	5
Job Security will be Lowered in the Future.	2	30	50	52	15	495	6
There will be a Tendency for the Hiring of Senior Workers to be Higher in the Industry.	9	32	59	36	14	464	7

Source: This study.

Note: Scores of 1 to 5 are assigned respectively to categories 'Very Unlikely', 'Unlikely', 'Fair', 'Likely', and 'Very Likely'.



Table 11. Possible Business Strategies to Cope with the Aging Trend in Taiwan

No. of Effective Observations: 152

Future Strategies	No. of Firms	(%)	Ranking
Enhancing Internationalization of the Operation	103	67.76%	1
Enhancing In-Service Training	91	59.87%	2
Enhancing R&D to Boost the Technological Cap.	77	50.66%	3
Enhancing Production Automation	70	46.05%	4
Enhancing Outward Investment Toward China	54	35.53%	5
Re-Adjusting the Internal Organizational Structure to be able to Hire More Middle-aged and Senior Workers	37	24.34%	6
Reducing Investment in Taiwan	10	6.58%	7

Source: This study.

Table 12. Possible Policies that the Government should Consider to Cope with the Aging Trend

No. of Effective Observations: 152

Relevant Policy Options	No. of Firms	(%)	Ranking
Wage Subsidies for Firms Hiring Senior Workers	84	55.26%	1
Relaxation of the Relevant Labor Law so as to Provide More Incentives to Hire Part-Time Workers	83	54.61%	2
Encouraging Firms to Internationalize their Operations	79	51.97%	3
Subsidies for In-Service Training Expenses	64	42.11%	4
Providing a More Comprehensive Child-care Program to Promote Female Labor Force Participation	64	42.11%	4
Subsides or Rewards to Encourage Increase in Newly-Born	46	30.26%	6
Allowing More Alien Workers to Work Legally in Taiwan	29	19.08%	7

Source: This study.

Table 13. Definitions of Relevant Variables and their Descriptive Statistics

Type	Variable	Explanation	Definition	Mean (S.D.)	Data Source	
Dependent Variables	LQ	Despite aging, the chance that the manpower quality can still be improved through more education.	0: No Chance 1: Unlikely 2: Fair 3: Likely 4: Very Likely	2.4145 (0.9863)	This Study's Survey	
	SHOCK	Whether or not the aging work force has had an adverse impact on the industry's development in Taiwan?	0: No, not yet. 1: Yes, it has.	0.6447 (0.4802)	This Study's Survey	
Explanatory Variables	(X <sub>1</sub> )	AGE	Years of Establishment	Years	17.0530 (8.6501)	Taiwan Economic Journal
		SALES	Gross Annual Sales	Sales revenue in 2005 (million NT\$)	17342.0926 (68903.0184)	Taiwan Economic Journal
		WORKER	Number of Paid Employees	Total Employed Workers in 2005 (person)	1057.6667 (2741.1870)	Taiwan Economic Journal
		SALARY1	Total Salary Payment	Total Salary Payment in 2005 (million NT\$)	685.8070 (2204.1693)	Taiwan Economic Journal
		SALARY2	SALARY1/ SALE	(%)	11.4462 (8.7471)	Taiwan Economic Journal
		RD1	R&D Expenditure	R&D Expenditure in 2005 (million NT\$)	421.6075 (1183.6087)	Taiwan Economic Journal
		RD2	RD1/SALE	(%)	4.1627 (4.6717)	Taiwan Economic Journal
		INVEST1	Engaging in Outward Investment?	0: No. 1: Yes	0.8278 (0.3788)	Taiwan Economic Journal
		INVEST2	Engaging in Outward Investment Toward China?	0: No 1: Yes	0.7285 (0.4462)	Taiwan Economic Journal
	(X <sub>2</sub> )	RE	Expected Difficulties in Recruiting R&D Personnel	1: Easy 2: Not so Easy 3: Fair 4: Difficult 5: Very Difficult	3.3759 (1.1247)	This Study's Survey
		T1	More Flexibility will be Observed for Work Hours, Job Assignment and Paid Vacation among Firms in the Industry.	1: Very Unlikely 2: Unlikely 3: Fair 4: Likely 5: Very Likely	3.4503 (1.1295)	This Study's Survey
		T2	The Utilization of Internet and Wi-Fi Related Products will be Intensified in the Industry	1: Very Unlikely 2: Unlikely 3: Fair 4: Likely 5: Very Likely	3.9592 (0.8904)	This Study's Survey

		T3	Relevant Arrangements for the Worker's Lifetime Learning will be Intensified	1: Very Unlikely 2: Unlikely 3: Fair 4: Likely 5: Very Likely	3.8912 (0.8369)	This Study's Survey
		T4	There will be an Increasing Trend for Self-Employed Workers in the Industry	1: Very Unlikely 2: Unlikely 3: Fair 4: Likely 5: Very Likely	3.4000 (1.0034)	This Study's Survey
	(X <sub>3</sub> )	E1	Enhancing In-Service Training	0: No 1: Yes	0.5987 (0.4918)	This Study's Survey
		E2	Reducing Investment in Taiwan	0: No 1: Yes	0.0658 (0.2487)	This Study's Survey
		E3	Enhancing Outward Investment Toward China	0: No 1: Yes	0.3553 (0.4802)	This Study's Survey
		E4	Re-Adjusting Internal Organizational Structure to be able to Hire More Middle-aged and Senior Workers	0: No 1: Yes	0.2434 (0.4306)	This Study's Survey
	(X <sub>4</sub> )	G1	Salary Subsidies for Firms Hiring Senior Workers	0: No 1: Yes	0.5526 (0.4989)	This Study's Survey
		G2	Allowing More Alien Workers to Work Legally in Taiwan	0: No 1: Yes	0.1908 (0.3942)	This Study's Survey
		G3	Relaxation of the Relevant Labor Laws so as to Provide More Incentives to Hire Part-Time Workers	0: No 1: Yes	0.5461 (0.4995)	This Study's Survey
		G4	Providing a More Comprehensive Child-care Program to Promote Female Labor Force Participation	0: No 1: Yes	0.4211 (0.4954)	This Study's Survey
		G5	Subsides or Rewards to Encourage More New Births	0: No 1: Yes	0.3026 (0.4609)	This Study's Survey
		G6	Subsidies for In-Service Training Expenses	0: No 1: Yes	0.4211 (0.4954)	This Study's Survey
		G7	Encouraging Firms to Internationalize their Operations	0: No 1: Yes	0.5197 (0.5013)	This Study's Survey

Table 14. Tobit Model to Examine the Possibility that Manpower Upgrading is Possible,  
Dependent Variable: Variable LQ

(t statistics)

Explanatory Variables	(1)	(2)	(3)	(4)	(5)	(6)
CONST	1.0972 (2.21)**	1.2567 (2.51)**	0.7632 (1.48)	1.0725 (2.17)**	0.9758 (1.95)*	0.5896 (1.18)
AGE	0.0258 (2.87)***	0.0337 (3.85)***	0.0269 (3.05)***	0.0345 (3.89)***	0.0336 (3.79)***	0.0264 (2.98)***
SALES	-3.243E-6 (-2.40)**	-3.487E-6 (-2.70)***	-3.194E-6 (-2.54)**	-3.07E-6 (-2.33)**	-2.645E-6 (-1.94)*	-2.77E-6 (-2.11)**
WORKER					1.47E-4 (1.16)	9.01E-5 (0.73)
SALARY1				-2.7E-5 (-0.65)	-1.98E-4 (-1.30)	-1.09E-4 (-0.73)
SALARY2	-0.0185 (-1.99)**	-0.0180 (-1.92)*	-7.249E-3 (-0.76)			
RD1	9.93E-5 (1.27)	1.32E-4 (1.74)*	1.15E-4 (1.56)	1.68E-4 (1.99)**	1.29E-4 (1.41)	1.0E-4 (1.13)
INVEST1			0.6393 (2.90)***			0.6666 (3.12)***
RE		-0.1229 (-1.77)*	-0.1086 (-1.61)	-0.1403 (-2.02)**	-0.1477 (-2.13)**	-0.1217 (-1.80)*
T1	0.0631 (0.89)	0.0668 (0.95)	0.0618 (0.91)	0.0638 (0.90)	0.0799 (1.11)	0.0697 (1.00)
T2	0.2817 (2.98)***	0.3120 (3.41)***	0.2723 (3.05)***	0.3073 (3.31)***	0.3156 (3.40)***	0.2777 (3.07)***
T3	-0.0972 (-0.91)	-0.1310 (-1.25)	-0.0863 (-0.85)	-0.1007 (-0.96)	-0.0971 (-0.93)	-0.0745 (-0.74)
E1	0.0778 (0.46)	0.1372 (0.84)				
E2	-0.7923 (-2.39)**	-0.5055 (-1.50)	-0.5594 (-1.75)*	-0.4830 (-1.46)	-0.4868 (-1.47)	-0.5275 (-1.65)*
G6	0.3118 (1.95)*	0.3760 (2.36)**	0.3588 (2.36)**	0.4133 (2.62)***	0.4180 (2.64)***	0.3641 (2.36)**
N	145	135	135	135	134	134
Log Likelihood for Normal	-191.1296	-171.6002	-167.8570	-173.3274	-171.7413	-167.0401

Note: \* significant at 10% level; \*\* significant at 5% level; \*\*\* significant at 1% level.

Table 15. Probit Model for Examining Whether or not Population Aging has had a Significant Negative Impact on the Development of Electronics Firms in Taiwan – Dependent Variable: SHOCK

Explanatory Variables	(t-statistics)					
	(1)	(2)	(3)	(4)	(5)	(6)
CONST	2.6984 (2.98)***	2.6019 (2.91)***	2.5988 (2.92)***	2.7479 (3.04)***	3.0301 (3.21)***	2.1033 (2.46)**
AGE	-0.0076 (-0.54)	-0.0086 (-0.62)	-0.0093 (-0.67)	-0.0065 (-0.47)	-0.0009 (-0.06)	-0.0036 (-0.25)
SALES	-4.487E-6 (-1.39)					
WORKER		-0.0001 (-1.39)				
SALARY1					-0.0001 (-0.91)	
SALARY2	0.0334 (1.82)*	0.0379 (2.04)**	0.0374 (2.03)**	0.0274 (1.65)*		0.0352 (1.85)*
RD1				-0.0001 (-1.32)	-0.0001 (-0.66)	
RD2	-0.0203 (-0.66)	-0.0183 (-0.58)	-0.0224 (-0.71)			-0.0112 (-0.37)
INVEST1					-0.6781 (-1.75)*	-0.4308 (-1.12)
RE	0.2657 (2.19)**	0.2678 (2.19)**	0.2690 (2.21)**	0.2606 (2.20)**	0.2215 (1.96)**	0.2109 (1.83)*
T1	-0.3817 (-3.32)***	-0.3719 (-3.25)***	-0.4084 (-3.51)***	-0.4060 (-3.49)***	-0.3637 (-3.23)***	-0.3770 (-3.33)***
T4	-0.2143 (-1.65)*	-0.2032 (-1.61)	-0.1889 (-1.48)	-0.1988 (-1.56)	-0.1650 (-1.35)	-0.2056 (-1.65)*
E3	-0.2819 (-1.04)	-0.3451 (-1.28)	-0.1954 (-0.71)	-0.2224 (-0.81)		
E4			0.4756 (1.54)	0.4229 (1.36)		
G1	-0.2515 (-0.90)	-0.2750 (-0.98)	-0.3263 (-1.15)	-0.3283 (-1.16)	-0.1227 (-0.45)	
G2	-0.9743 (-2.47)**	-0.9096 (-2.30)**	-0.9973 (-2.51)**	-0.9915 (-2.55)**	-0.7905 (-2.08)**	-0.6856 (-2.03)**
G3	-0.5361 (-1.78)*	-0.5542 (-1.84)*	-0.5854 (-1.92)*	-0.6555 (-2.12)**	-0.4875 (-1.67)*	-0.2482 (-1.00)
G4	-0.4649 (-1.51)	-0.4410 (-1.44)	-0.5757 (-1.84)*	-0.5393 (-1.74)*	-0.3540 (-1.20)	-0.2351 (-0.89)
G5	-0.4885 (-1.56)	-0.3978 (-1.26)	-0.4642 (-1.48)	-0.4764 (-1.51)	-0.3345 (-1.10)	-0.2750 (-0.94)
G6	-0.4021 (-1.30)	-0.4433 (-1.42)	-0.4264 (-1.37)	-0.4793 (-1.52)	-0.3187 (-1.06)	
G7						0.2598 (1.00)
N	139	138	139	139	139	139
Log Likelihood for Normal	-75.5359	-75.7749	-76.2422	-75.5735	-77.4463	-77.6018

Note: The same as Table 14.

