



On Global Equilibrium of Work and Retirement in the 21ST Century

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Abstract

As we enter the 21st century, many questions regarding work and retirement income plans in the new century have been raised. A few such questions are highlighted: What will a 21st century career look like? What will the risks to that career be, particularly in the later third of the working lifetime? What tools could be used to manage those risks? What is the social contract? Who should decide at what ages we provide protection, to whom, from what, and at what levels? What programs will employers need to help manage their workforces in the 21st century so as to remain profitable and viable? Should pension and benefits plans be considered in a more cohesive way than the existing regulatory frameworks permit in many countries? The goal of this paper is to introduce our globalization model of work and retirement in the 21st century. To fully understand the model, we have to highlight in quite detail the new knowledge-based economy and its role in the global labor market and illustrate in detail with the international market of higher education and its knowledge workers. After giving sample piecemeal solutions to the problems as raised in the above, we introduce our globalization model with additional proofs of the existence of equilibrium from mathematics and game theory. To make our model work, we need a prototype social security system with many desirable features called NPF (National Provident Fund) for each nation and so we briefly describe it and leave the great details to the lead author's other published papers. Finally, we apply our model to answer many questions; some of them are highlighted in the above.

Keywords: Globalization; Equilibrium; Fixed point theorem; Social security system; Longevity; Life expectancy; Knowledge-based economy/society; Knowledge worker; Individual retirement account; Long term care; Fully equitable; Fully funded; Fully vested; Fully portable; Intergenerationally independent

“May all the nations soon throw down the barriers which separate them.” ----- Frederic Bastiat

“Imagine there's no countries.” -----John Lennon

“Anyone who is tired of globalization is tired of life.” -----Samuel Johnson

1. Introduction

The current U.S. and Canadian retirement systems were designed long ago during the time periods when birth rates, life expectancies, retirement age, life expectancies at retirement, immigration rates and even interest rates and foreign exchange rates were all highly predictable and quite stable. The systems were then built understandably for the simple and clear-cut cliff retirement and they worked well even into the 1960s and 1970s. Over

the decades since then, additional measures were further introduced into the systems to ease retirement and protect workers.

st In the most recent past decades as we entered the 21 century, we face a completely different situation which has been changing rapidly in the historical perspective. Because of low birthrates, there are fewer younger workers coming into the workforce to replace the retiring people. At the same time, longevity is increasing and the average retirement age is decreasing. The average 65-year-old male in the U.S. can expect to live to be 84, and has a 25% chance of living to be 91. Women have an even longer life expectancy.

Over the coming decades, the situation is expected to become worsening. And it is quite clear now that North American society can hardly sustain an economic system where a large proportion of individuals work as little as 30 years and then are retired for 25 to 30 years or more. Even if many individuals are able to accumulate the retirement savings required, employers over the next decade or so will find that they can not afford losing their valuable resource of older workers simply because

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there are insufficient younger workers to take their places.

In this paper, we will address this issue from a global perspective and hope to solve this local North American problems globally. To make our presentation clear, we will first highlight in quite detail the new globalized knowledge-based economy, and illustrate in detail with the international market of higher education and knowledge workers. We will then give sample piecemeal solutions to the problems and then introduce our globalization model of work and retirement with additional proofs of the existence of equilibrium from mathematics in Appendix 1 and game theory in Appendix 2. To make our model work, we need a prototype social security system with desirable features called NPF (National Provident Fund) for each nation. Finally, we will answer all the questions we have encountered and collected from the models.

2. The New Knowledge-based Economy

Throughout the few decades toward the end of last century until now, we have witnessed the convergence of the following forces intensifying rapidly over the time:

2.1 The use of personal computers, internet, information technologies, and all sorts of communication devices and equipments. All told, the death of distance is being realized.

2.2 The collapse of Communist countries and their adoption of free-market economic systems.

2.3 Globalization.

2.4 Competition.

These forces reinforce each other so rapidly that even China emerges quickly as the world's manufacturing factory and Taiwan, among other countries, one of the world's leading high-tech OEM (original equipment manufacturing) countries. In just few decades, countries such as Taiwan, South Korea, Singapore, Hong Kong, and China realize quickly that the profit margins of the goods and services they produce have been decreasing steadily due to low-cost competition. And they all can appreciate U.S. economist Paul Krugman's 1990s critique of East Asia's export-based economies, in which he touted the benefits of "inspiration" rather than "perspiration". Thus, the policy to produce higher value-added goods and services is formed and the new knowledge-based economy is ushered in and rising.

The world is now in the grips of a "soft revolution" in which knowledge is replacing physical resources as the main driver of economic growth. The OECD calculates that between 1985 and 1997 the contribution of knowledge-based

industries to total value added increased from 51% to 59% in Germany and from 45% to 51% in Britain. The best companies are now devoting at least a third of their investment to knowledge-intensive intangibles such as R&D, licensing and marketing. Under the "soft revolution", the secret to future growth lies in creativity, innovation, invention and originality. In other words, it is imperative to be creative, innovative, inventive and original.

In the knowledge-based economy, we have observed not only low birth rates, increasing longevity, early retirement age, but also low family formation, changing family pattern and changing retirement pattern. In addition, we have also observed the following changes such as the shift from nation state to business state, shift from fixed to flexible and responsive systems, shift from short-term to long-term outlook, shift from reliance on institutional help to self-help, shift from complacency to accountability, the formation of trade blocs and harmonization of standards among nations, increasing labor mobility not only within a political boundary but also across nations, and the development of a new and global lifestyle.

In a knowledge-based society, there are three main characteristics:

2.5 Borderlessness, because knowledge travels even more effortlessly than money.

2.6 Upward mobility, available to everyone through easily acquired formal education.

2.7 The potential for failure as well as success. Anyone can acquire the knowledge required for the job but not everyone can win.

These characteristics together will make the knowledge-based society a highly competitive one, for organizations and individuals alike. Given the ease and speed at which information travels, every organization in the knowledge-based society has to be globally competitive, even though most organizations will continue to be local in their activities and markets. This is because the Internet will keep customers everywhere informed on what is available anywhere in the world, and at what price.

Research on the productivity of knowledge workers has barely begun. Peter Drucker in his book "Management Challenges for the 21st Century" concluded that there are six major factors which determine knowledge-worker productivity:

2.8 Knowledge-worker productivity demands that we ask the question: "What is the task?"

2.9 It demands that we impose the responsibility for their productivity on the individual knowledge workers themselves. Knowledge workers have to manage themselves. They have to have autonomy.

2.10 Continuing innovation has to be part of the

work, the task, and the responsibility of knowledge workers.

2.11 Knowledge work requires continuous learning on the part of the knowledge worker, but equally continuous teaching on the part of the knowledge worker.

2.12 Productivity of the knowledge worker is not – at least not primarily – a matter of the quantity of output. Quality is at least as important.

2.13 Knowledge-worker productivity requires that the knowledge worker be both seen and treated as an “asset” rather than a “cost”. It requires that knowledge workers want to work for the organization in preference to all other opportunities.

Based on the above six factors, one can easily conclude that knowledge workers must have continuous learning built into their tasks. And a knowledge organization has to be both a learning organization and a teaching organization. This means that knowledge workers are well advised to answer these two questions:

2.14 What do I need to learn to keep abreast of the knowledge I am being paid to know?

2.15 What do my associates have to know and understand about my knowledge area and about what it can and should contribute to the organization and to their own work?

One can further conclude that knowledge workers and the organization they work for are mutually dependent on each other. Moreover, no knowledge “ranks” higher than another.

Drawing from what we have described in the above, one is not surprised at the high price of success in the knowledge-based society: the psychological pressures and emotional traumas of the rat race. There can be winners only if there are losers. This was not true of earlier societies.

Japanese youngsters suffer sleep deprivation because they spend their evenings at a crammer to help them pass their exams. Otherwise they will not get into the prestige university of their choice, and thus into a good job. Other countries such as America, Britain, and France are also allowing their schools to become viciously competitive. That this has happened over such a short time – no more than thirty or forty years – indicates how much the fear of failure has already permeated the knowledge-based society.

Today the new jobs require a good deal of formal education and the ability to acquire and apply theoretical and analytic knowledge. They require a different approach to work and a different mind-set. Above all, they require a habit of continuous learning. What mix of knowledge is required for

everybody? What is “quality” in learning and teaching? All these will become central concerns of the knowledge-based society and central political issues. In fact, Peter Drucker stated in his book “Managing in a Time of Great Change” that “it may not be too fanciful to anticipate that the acquisition and distribution of knowledge will come to occupy the place in the politics of the knowledge-based society that the acquisition of property and income have occupied in the two or three centuries that we have come to call the Age of Capitalism.”

Since education has clearly become the center of the knowledge-based society and schooling its key institution, we will look at the most important part of education – the higher education in the international market – and how that market functions also as the distributor of the best and brightest knowledge workers among industries, nations, societies and economies.

3. The International Market of Higher Education

Due to the four forces we mentioned in 2.1 through 2.4 and the rise of the knowledge-based economy, universities worldwide have become more diverse, more global, and much more competitive. As the suppliers of higher education, they have been experimenting with new ways of funding, forging partnerships with private companies and among themselves, engaging in mergers and acquisitions, and even creating among themselves for-profit universities. From the demand side, the proportion of adults with higher educational qualifications in the OECD countries almost doubled between 1975 and 2000, from 22% to 41%. China doubled its student population in the late 1990s, and India is trying to follow suit. The number of people from OECD countries studying abroad has doubled over the past 20 years to 1.9 million. To meet the global demand, universities are opening campuses all around the world and a growing number of countries are trying to turn higher education into an export industry. The World Bank calculates that global spending on higher education amounts to \$300 billion a year. There are more than 80 million students worldwide, and 3.5 million people are employed to teach them.

America in the market of higher education has almost a monopoly on the world’s best universities (According to Shanghai’s Jiao Tong University latest rankings, 17 of the world’s top universities are American) but also provides access to higher education for the bulk of those who deserve it. America spends 2.7% of its GDP on higher education, compared with only 1.1% in European countries. American universities have between two and five times as much to spend per student as European universities, which translates into smaller classes, better professors and higher-quality research. The European Commission estimates that 400,000

EU-born scientific researchers are now working in the United States. Most have no plans to return. Europe produces only a quarter of the American number of patents per million people.

Across the developing world, governments are rapidly expanding their higher education systems for two main reasons: the dramatic growth in the supply of potential students and a revolution in economic thinking strongly in favor of the positive effect of university based research on the economy. Two countries stand out among others: India and China. In India, the number of people attending universities almost doubled in the 1990s, from 4.9 million to 9.4 million. India has its collection of elite institutions such as the All India Institute of Medical Sciences, the Indian Institute of Science in Bangalore and, above all, those seven Indian Institutes of Technology (IITs). These institutions take their pick from an army of candidates every year, with 180,000 hopefuls taking the screening test for around 3,500 places in the seven IITs. They provide a highly intensive education and produce a stream of highly educated people who help keep India plugged into the global knowledge-based economy.

It is well known, however, that these elite institutions have produced many people who get brain-drained away to North America where they end up staying permanently. In fact, the combined net worth of Indian IIT graduates in America is reportedly \$30 billion. Even the late Indian prime minister Rajiv Gandhi has said: "Better brain drain than brain in the drain." Few highly skilled migrants cut their links with India completely. Most keep in touch, sending remittances and now venture capital, circulating ideas and connections, and even returning home as successful entrepreneurs. A growing number of Indian students go home after a spell abroad to take advantage of the hot labor markets in Mumbai, Bangalore, Hyderabad. And a growing number of expatriate businessmen invest back home.

China, being the world's most populous country, is similar to India in many aspects of higher education except that it is "ahead" of India. For example, China has far more students attending universities ; in 2003, 17% of high school graduates went to university. China's best universities take their pick from an even larger pool of candidates every year. Perhaps Chinese college graduates are more keen than their Indian counterparts to go abroad for further study. In China, the No.1 goal of best students is to receive a full scholarship from an American university so that they can leave China upon graduation. Those stay to enter a Chinese graduate school are second-tier students. Similar to Indian students, those who do well in North America

(more than two thirds) stay there permanently. In North America, they behave just like those highly skilled Indian migrants. A growing number of Chinese also go home to take advantage of the hot labor markets in Shanghai, Beijing, etc.

For students from developing countries, international higher education is not only becoming a borderless world but also a sure way to change their destiny. The number of foreign students in the OECD has doubled to 1.5 million over the past 20 years. The world's best and brightest students – especially graduate students – want to study at the world's best universities. Two of the biggest exporters of students in absolute numbers are China (with 10% of all those studying abroad) and India (with 4%). This growth has even been speeded up further recently due to competition for talent; many developed countries are amending both their education and immigration policies in order to attract highly qualified knowledge workers.

Several countries – most notably Australia and New Zealand – are trying to turn education into an export industry. Foreign students are triply valuable. They pay fees to universities, spend money on things like food and lodging, and may even end up staying on permanently. For the past 50 years, America has dominated the market for international students, who have brought both direct and indirect benefits. Not only are they contributing some \$13 billion a year to America's GDP, they are also supplying brainpower for its research machine and energy for its entrepreneurial economy. According to OECD, in 2002 America attracted 30% of all foreign students in tertiary education well ahead of the second place Britain with about 13%. Again, OECD report shows that America is the most brain-gaining (with most stock of highly skilled immigrants) country with 8.2 million, followed by Canada (about 2.2 million) and Australia (1.8 million).

In today's global knowledge-based economy, the university is undergoing a dramatic transformation to becoming a global university. It is increasingly operating in a global labor market. Faculty searches are always worldwide ; in some departments 40% of Ph.D. students come from abroad; and the graduate and professional schools are truly multinational. All told, the great universities of today, being shaped by globalization, are competing with each other for talent and prestige worldwide and the best and brightest students are being showered with creative offers of packages.

Today's great universities are citizens of an international academic marketplace with one global academic currency, one global labor force and, increasingly, one global language, English. They are also increasingly citizens of a global economy, sending their best graduates to work for multinational companies.

Conversely, access to global market is needed to put together first-rate teams of researchers. In return, they produce a disproportionately large share of cutting-edge ideas and research. Along the way, they can also produce outsize economic benefits. The best-known example of this is Stanford which helped to incubate Google, Yahoo!, Cisco, Sun Microsystems and many other world-changing firms.

Great universities are a valuable asset in the global war for talent too. America's great research universities enable it to recruit more foreign Ph.D. students than the rest of the OECD put together. And a striking number of these people stay put: in 1998-2001, about two-thirds of foreigners who earned American doctorates in science and engineering said they had "firm plans" to stay, up from 57% in 1994-97. The benefits of having global universities are now so clear that governments around the world are obsessed with producing their own "Ivy Leagues".

4. Globalizing Work and Retirement

Facing the "sudden" arrival of the new knowledge-based economy, governments and businesses have reacted in a piecemeal approach. To deal with low birth rates and the shrinking of the younger population, countries and companies are putting the retireds back to work or finding ways to keep older workers on the job. However, in Japan even if all older workers are re-hired, its projected work force will be smaller than now after 2010. To deal with early retirement, businesses and governments raise the normal retirement age in steps or gradually. To simultaneously deal with these and other problems and the heavy burden of pension, retiree medicals and employee benefits, businesses resort to outsourcing contractors, part-timers, temporaries, freelancers, PEOs (Professional Employer Organizations), BPOs (Business Process Outsourcing firms) and outright downsizing. Multinational corporations have even moved entire labor-intensive departments, including call centers, to low cost countries such as India, Philippines, etc. The latter has become the well-known public issue of job loss from off-shoring in the U.S.A.

What Singapore government has been doing in dealing with these problems may be noteworthy. Just like other countries, they have been raising the normal retirement age from age 55, 60, 62, and on, for pension purpose. What is most striking is its immigration policy. In the past ten years or so, Singapore's population has increased from about 2.8 million to 4.2 million (1.5 time!) now. They make coordinated efforts to systematically attract young and mostly knowledge workers from all over the

world. To those who are highly skilled such as those who own a doctoral degree from, say, U.S.A., they first offer them speedy preferential treatment to help them obtain permanent residency. Once they get the P.R., Singapore government "forces" them to become a citizen by imposing time limit for them to enjoy further preferential treatment to become a citizen. It appears that such a huge modern immigration movement has solved Singapore's problems.

All the above approaches to the problems are considered piecemeal, unsystematic, self-interest, local and non-global. They are not for the global good. On the other hand, millions of migrant workers from developing countries and emerging economies such as Mexico, Philippines, Morocco, Pakistan, Bangladesh, etc. are "forced" by sheer survivorship to work in rich countries such as North America and EU. They have to endure layer after layer's hardship and cost, bureaucratic charges, fees and red tape, and even pay high fees to smugglers to help them cross national boundaries. Most migrant workers scrape by in first-world cities, depriving themselves of basic comforts in orders to "keep people live" back home. According to the World Bank, remittances – the cash that migrants send home – were expected to exceed \$232 billion in 2005, nearly 60% higher than the number for 2000. Of that, about \$167 billion goes to poor countries, nearly double the amount in 2000.

In many of those countries receiving the remittances, the money from migrants has now overshoot exports, and exceeds direct foreign aid from other governments. In fact, experts believe that the true figure for remittances in 2005 was probably closer to \$350 billion, since migrants are estimated to send one-third of their money using unofficial methods, including taking it home by hand. That money is never reported to tax officials, and appears on no records. Undoubtedly, mass migration has produced a giant worldwide economy all its own. The top 5 recipients of remittances in 2005 are, in descending order, India, China, Mexico, Philippines, and Morocco. According to Jeffrey Joerres, Chairman and CEO of Manpower Corp., 1 billion workers from emerging economies have entered the global labor market since 2000.

From what we have described above, we can see clearly that the global labor market is far from being efficient. America's cry over job loss from off-shoring is focusing on protecting American jobs. If they succeed, they will feel very good today but regret it massively in the future. So the America's public rhetoric of only saving jobs in America and not letting off-shoring happen is just for the short-term local good but not for the long-term global good because all it will do is to create a noncompetitive environment which America may not be able to get out of. This is the same as in the

theory of international trade where protectionism can bring short-term national good to the country being protected by raising trade barriers, but not for long-term bilateral good to trading partners. Needless to say, we need free trade for the long-term global good.

Similarly, migrant workers should not be enduring so much migration barriers such as enormous cost, hardship, red tap, middlemen fees and charges etc. Economic theory of price concludes easily that free migration brings long-term good to both migrant workers and their employers in the hosting countries. The type of immigration to North America of Indian and Chinese scientists and engineers through graduate studies in North American universities as described in Section 3 may be close to barrier-free by today's standard. But the Institute of International Education reports that the number of foreign students on American campuses declined by 2.4% in 2003-04, the first time the number has gone down in 30 years. Many universities blamed the tightening of visa rules after September 11, 2001.

In summary, we need a systematic, global model which will do global good in order to globalize work and retirement. For ease of illustration but without loss of generality, we will consider only knowledge workers. For each and every knowledge worker in the world, he (for simplicity) must consider his education, experience, skills, professional qualifications, financial condition, moving cost, attitude toward change, ability to take pressure and endure hardship, appetite for taking risk, value concept, weather, distance, living condition, health condition, future prospect, probability of success vs failure, salary, pension, employee benefits, vacation, culture, entertainment, opportunity at home and abroad, life philosophy, etc. before he decides to make a move in the global labor market. For simplicity, we will call these n factors which are complete in the sense that no single factor a worker may consider is outside of this list. To each worker, we associate a mathematical function of n such factors. And each worker with his own function of n such factors will end up with his best possible job in the migration-barriers-free international labor market and we call his best possible job his functional value.

Just as in economic theory, we will assume all workers are rational and so a very small change in these n factors will correspond to a very small change in one's own functional value to such an extent that each function possesses very nice properties such as continuous, differentiable, continuously differentiable etc. All such functions constitute a dynamic system or a flow in

mathematics. If we have 2 billion such workers in the global labor force, we have then obtained 2 billion such functions in this process. The time-independent solution of such a dynamic system is called an equilibrium. Please see Appendix 1 for details.

Such a dynamic system or flow may be time-dependent in that each worker may change his functional value throughout his career or some technological breakthrough such as internet may change each worker's functional value to various degrees. In that case, the associated dynamic system can be solved by finding its fixed point. Please see Appendix 1 on this. In Appendix 2, we also include a couple of more well-known fixed point theorems with weaker assumptions and so wider applications. In any case, we can conclude that an equilibrium may be reached in the migration-barriers-free global labor market.

To make our model work, we need another model called National Provident Fund (NPF) which is a social security system to be set up in each nation. In Singapore, it is called Central Provident Fund; in Hong Kong, Mandatory Provident Fund and in Malaysia, Compulsory Provident Fund. On July 1, 2005, Taiwan started its new pension regulations and has effectively set up such a NPF. In March, 2004, the lead author presented a paper to Applied Actuarial Research Conference in Orlando, Florida on "An U.S. Federal Provident Fund Integrating Social Security, LTC, Health Care, and Occupational Pension Schemes" which is the design of such a social security system for U.S.A. For details, please see papers listed in the Reference.

Briefly, a NPF is a compulsory social security savings scheme. Both employers and employees must contribute jointly a certain percentage of the employees' monthly salaries to their individual retirement accounts which may be subdivided into such subaccounts as regular, medical expense, LTC, and emergent. The reason NPFs are so important in the globalization of work and retirement is that they possess the following distinguished features:

- 4.1 Fully Equitable
- 4.2 Fully Funded
- 4.3 Fully Vested
- 4.4 Fully Portable
- 4.5 Intergenerationally Independent
- 4.6 Fully Reciprocal Across National Boundaries
- 4.7 Encouraging Private Intergenerational Transfers
- 4.8 Encouraging Late, Phased, or Flexible Retirement
- 4.9 Emphasis on Saving and Personal Responsibility
- 4.10 Emphasis on Employer Responsibility
- 4.11 Provides for Disability, LTC, and Medical Expenses

5. Applications

Armed with the above models, we can now answer all the questions we have encountered and collected.

5.1 What will a 21st century career look like? What will the risks to that career be?

The problems with the original design of existing retirement systems lie in the fact that they paid no attention to the vast differences among workers. Our models, on the contrary, focus on each worker's individuality and so a 21st century career looks just as hugely different as a human being could be. To appreciate this, just look at the functional values of those functions of n factors in Section 4 above. The risks, if any, to such a career are entirely within the control of each worker when he takes up his best possible job in the global labor market by considering all those n factors.

5.2 What tools could be used to manage those risks?

As mentioned in item 5.1, those risks, if any, are entirely within the control of each individual worker. In the new knowledge-based economy, it is each knowledge worker's responsibility to continuously improve his productivity. Please see items 2.8 through 2.15 to more fully appreciate this. In such a new economy, each knowledge worker is completely free to take sabbatical or not, to undergo retraining or not, to enjoy shorter or longer work weeks or not, to take more or less vacation or not, etc. All the same, knowledge workers have the complete freedom to work intermittently, to take long breaks, to work well into their 90s just as Peter Drucker did, all as they see fit. In fact, they are virtually immune from mergers, acquisitions, and even bankruptcies in sharp contrast to those former employees of ENRON and World Com. For a concrete tool, Singapore's CPF is an outstanding example.

5.3 What are the cultural changes that need to take place? How might these cultural changes drive broad changes in other areas?

The answers to these questions have been scattered throughout this paper especially in sections 2 and 3. To keep this paper from becoming excessively long, we will not summarize them here.

5.4 What is the social contract? Who should decide at what ages we provide protection, to whom, from what, and at what levels?

In the global labor market where economies are based largely on knowledge as we have described throughout this paper, these questions may no longer be valid or simply inapplicable any more.

5.5 What programs will employers need to help

manage their workforces in the 21st century so as to remain profitable and viable? How do you change the existing plan or design a new program that is more cost-efficient and flexible?

All the employers need to do is to follow instructions from NPF to be set up in each nation to make monthly contributions to their employees' individual retirement accounts. The contributions may vary according to many factors such as each nation's macroeconomic condition, each particular industry in what business cycle, etc. When the NPF is introduced, allow those members who are also covered under an existing plan to choose between these two plans during a well-defined transition period. This is exactly how Taiwan did when it introduced its de facto NPF on July 1, 2005.

5.6 Should pension and benefits plans be considered in a more cohesive way than the current U.S. and Canadian regulatory frameworks permit?

Absolutely. And NPF is such a cohesive plan because it includes not only pension and medical expenses but also LTC and else.

5.7 How do you manage morbidity risks in later life?

All the possible sub-questions arising from this question such as taking long illness break and then re-entering the workforce, high cost retiree medical benefits, etc. are answered in our models. In the case of managing the risks of disability that might force a mid-career retirement and a very long retirement period, the design of NPF allows (1) members to use fund from medical expense subaccount to buy catastrophic insurance, disability income insurance, etc. (2) family members and the patient's immediate family to pool their accounts to pay a bill (3) members who have exhausted all means to utilize the "social net" provided by their government.

5.8 What choices should employees be offered regarding how they enter retirement?

None. In the global labor market and the new knowledge-based economy as we envision throughout this paper, every knowledge worker has the complete freedom to move around the labor market or to change the functional value of his function of n factors.

5.9 What are the issues facing individuals who accumulate retirement assets as part of a couple, but spend assets as singles? What are the particular issues for women?

Our models focus on each individual worker and so in the case of a couple, if both are working, each has his/her individual retirement account. For those particular issues for women, one should either understand the design of NPF thoroughly or get more

understanding from the answer to item 5.7.

5.10 How do you make any new retirement system work for small and medium size employers? What sort of purchasing cooperatives, industry-shared plans would be required?

The answer to the first question is the same as that to the first question in item 5.5. The answer to the second question is NO simply because our models focus on individuals.

5.11 What particular transition issues would exist, particularly if a society decides to abandon current systems and adopt new ones?

Please see answers to item 5.5. And all the other transition issues, if any, are scattered throughout the paper implicitly or explicitly.

5.12 What lessons can be learned from other countries?

(1) A social security system must take into serious consideration all major trends in changes and shifts in demographic, family, retirement, and lifestyle patterns.

(2) A social security system must possess as many desirable features as NPF does.

(3) In the global labor market where economies are essentially based on knowledge, competing for the best and brightest minds should begin with the questions: "What do they want? What are their values? What are their goals? What motivate them? What do they consider results?"

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APPENDIX 1

The state at time t is denoted by a vector X(t). A change of X(t) is made corresponding to a disturbance. This is expressed as

$$dX(t)/dt = F(X(t),t), \dots \dots (1)$$

starting with $X(0)=X_0$

In the special case $F(X(t),t)=F(X(t))$, (1) becomes

$$dX(t)/dt = F(X(t))$$

$$X(0)=X_0 \dots \dots (2)$$

This is called an autonomous system.

Usually, (2) is equivalent to a kind of Volterra integral equation or a compact (completely continuous) operator T in general which attains its

fixed point $X(t)=X(X_0, t)$ ($X(X_0, 0)=X_0$) as a solution of (2). That is $TX(t)=X(t)$. See [1] P.165.

The fixed point can be obtained by iterations of one kind or another, by starting with $X_1=TX_0$ and then $X_n=TX_{n-1}$ and so on.

The $n-1$ mapping $(t, X_0) \rightarrow X(X_0, t)=X(X_0)$ is a flow (dynamical system) of (2). See [1] P.175.

If a constant vector satisfies $F(X_0)=0$, then $(t) \equiv X_0$ is a solution of (2) which is called an equilibrium (critical) solution. Since $(t) \equiv X_0$ is also called a stationary point of (2).

An equilibrium is stable if near by solutions stay nearby for all future time. In applications, we only approximate the states, so that an equilibrium must be stable to be "physically"(in the broad sense) meaningful. See [1] P.185.

Stable equilibriums include two cases ; one is called asymptotically stable with $X(t) \rightarrow X_0$ for $X(0)$ near X_0 and the other periodic (conservation). See [2] P.266.

Those initial conditions that give rise to stable solutions form a set called stable manifold.

Going back to the general equation (1), we can look at it as a perturbation of (2) so that a similar stable result can be obtained. See [1] P.309.

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[2] Robert McOwen, *Partial Differential Equations, methods and applications* Prentice-Hall, Inc. 1996

APPENDIX 2

1. The Brouwer Fixed Point Theorem.

Let S be a compact convex subset of n-dimensional Euclidean space, and let f be a continuous function mapping S into itself. Then there exists at least one x in S such that $f(x) = x$.

2. The Schauder Fixed Point Theorem.

Let A be a compact, convex set in a Banach space X and $T : A \rightarrow A$ be continuous. Then T has a fixed point x in A.