Yale University

EliScholar – A Digital Platform for Scholarly Publishing at Yale

Discussion Papers   Economic Growth Center

4-1-1992

Pensions

Xavier Sala-i-Martin

Recommended Citation

Sala-i-Martin, Xavier, "Pensions" (1992). *Discussion Papers*. 665.
https://elischolar.library.yale.edu/egcenter-discussion-paper-series/665

ECONOMIC GROWTH CENTER

YALE UNIVERSITY

Box 1987, Yale Station
27 Hillhouse Avenue
New Haven, Connecticut 06520

CENTER DISCUSSION PAPER NO. 657

PENSIONS

Xavier Sala-i-Martin
Yale University

April 1992

Abstract

In this paper I develop a positive theory of intergenerational transfers. I argue that transfers are a way to induce retirement, that is, to buy the elderly out of the labor force. The reason why societies choose to do such a thing is that aggregate output is higher if the elderly do not work. I model this idea through externalities in the average stock of human capital: because skills depreciate with age, one implication of these externalities is that the elderly have a negative effect on the productivity of the young. When the difference between the skill level of the young and old is large enough, aggregate output in an economy where the elderly do not work is higher. Retirement in this case will be a good thing to have; pensions are just the means by which such retirement is induced.

Since the Ricardian Equivalence theorem says that, to a first approximation, intergenerational transfers are irrelevant, the mere existence of such transfers throughout the world could be seen as an embarrassment to Ricardian economists. The theory developed in this paper explains why there may be transfers, even if altruistic agents are linked through bequests.

Unlike other theories of transfers, the theory in this paper is consistent with a number of regularities: transfers appear to be a luxury good that societies buy only after they reach a certain level of development and income, transfers are the only component of public spending that appears to be positively correlated with growth in a cross section of countries and finally; and transfers are linked to retirement and to the employment history of the worker.

One key prediction of the model is that if the dependency ratio keeps rising, then the social security system will collapse, and that this will be the optimal thing to happen.

"My...fixed idea is the uselessness of men above sixty years of age, and the incalculable benefit it would be in commercial, political and in professional life if, as a matter of course, men stopped work at this age...That incalculable benefits might follow such a scheme is apparent to any one who, like myself, is nearing that limit, and who has made a careful study of the calamities which may befall men during the seventh and eighth decades. Still more when he contemplates the many evils which they perpetuate unconsciously, and with impunity".

These words are taken from Dr. William Osler's controversial valedictory address at Johns Hopkins University on February 22, 1905 (see Osler (1910) and Graebner (1980)). After sixteen years in Baltimore as physician–in–chief of the University Hospital, Osler was about to leave to Britain as Regius Professor of Medicine at Oxford. This last address was to be one of his main contributions to American society as it became the starting point of the first debate over mandatory retirement in this country's history.

Attracted by the Doctor's reputation as one of the top American physicians, the press correctly perceived that the public would be interested in his original yet scandalous vision of aging. His remarks about the 'uselessness of men above sixty years of age' made the headlines all around the country. The Washington Times wrote: *"Dr. Osler declares that men are old at 40 and worthless at 60. There must be an age at which a man is an ass. What is the doctor's age anyhow?".* The newspapers characterized the Doctor's views as 'insensitive', 'too rationally and too aggressively in search of efficiency and productivity', and 'cold–blooded'.[1] Some newspapers even reported that Osler's lecture was a call for euthanasia at the age of sixty. Senators quickly highlighted the great historical contributions of political figures over sixty. Professors, businessmen and professionals were outraged and felt threatened by the physician's views. James Angell, president of the University of

_____

[1]White (1937).

Michigan, reiterated that men above sixty were not useless: *"I would like to extend the time of a man's life instead of shortening it. The experiment of killing off old men has been tried in Africa for centuries, and I would suggest to the distinguished physician that civilization has not advanced very rapidly there"*.[2] For the first time in United States history, people debated whether free individuals should be forced to retire for age reasons[3]. The debate ended in 1935 with the enactment of the Social Security Act and the creation of what was to become one of the largest public budgets in the world.

In the United States today, transfers represent about 12.7% of GDP (up from 5% in 1940) and account for 46% of total government spending. As a comparison, public investment represents about 4% of GDP –only one third of that is non defense investment– and account for 13% of federal spending while defense purchases account for 21% of public spending and represent 5.6% of GNP. The largest and fastest growing component of transfer payments is the benefits paid through social security. For example, the expenditures for old age survivors and disability insurance increased from .3% in 1950 to 5.6% in 1991. Most of the other components of government spending have remained more or less constant (or sharply decreased in the case of defense purchases) throughout the same period (see 1992 Economic Report of the President).

Despite the large and growing importance of transfers, most of the researchers studying the determinants of long run economic growth have ignored the existence of

---

[2]White (1937). It has been recently found that African tribes stole the idea of killing off the elderly in order to enhance long run growth from dinosaurs, who used to hurl their elderly over a cliff as soon as they became a burden to the herd. See ABC television's series "Dinosaurs" (ABC, (1991)) for some interesting examples.

[3]Most Americans at the time thought that mandatory retirement was an unacceptable public interference with personal freedom, much in the spirit of Orwellanism and Socialism. This public sentiment seems to have come back in the eighties with the debates over the unconstitutionality and consequent abolition of mandatory retirement laws (Age Discrimination in Employment Act).

transfers.[4] Following Barro (1990), a substantial fraction of the literature has concentrated on the positive effects of public investment and the negative effects of public consumption and distortionary taxes. Transfers have been modeled as something that provides social utility (maybe because underlying them there is some kind of socially desirable redistribution aspect) and need to be financed with distortionary taxes (see for instance Lee (1991), Persson and Tabellini (1991), and Alesina and Rodrik (1992)). From a growth perspective, therefore, transfers are a bad thing to have. Yet if one includes transfers in a cross country regression of the type used by Barro (1991), one is surprised by the fact that among the three components of public spending (public investment –GI–, public consumption –GC–, and public transfers –SS), the only one that seems to be positively related to growth is the transfer variable. Public consumption spending is negatively related to growth and public investment is insignificant. An example of such regressions is the following

$$\text{Gr7085} = -.000 - .015 \cdot \text{Ln(GDP70)} - .129 \cdot \text{GC} - .228 \cdot \text{GI} + .111 \cdot \text{SS} + .217 \cdot \text{I}$$
$$(.004) \qquad\qquad (.047) \quad (.155) \quad (.054) \quad (.041)$$

$R^2 = .39$, s.e.$=.0182$, obs.$=74$.

where the log of initial per capita GDP –ln(GDP70) and the investment share –I– have also been included (the dependent variable is the annual average growth rate of per capita GDP taken from Summers and Heston).

From a Ricardian perspective, the mere existence of widespread transfer programs around the world is seen as an embarrassment. In a Ricardian world, altruism and bequests link generations in a way that makes lump sum transfers

---

[4]One of the initial motivations of this paper was my dissatisfaction with such treatments. I wanted to provide a framework to think about transfers and study their effects on long run growth.

irrelevant (Barro (1974)). If, to a first approximation, transfers are irrelevant, it is hard to explain why virtually all countries on planet earth implement such programs (especially if they are financed with distortions and administered by inefficient bureaucracies!). *And this is one of the main challenges of this paper: I want to explain why intergenerational transfers may exist in a Ricardian world where parents care for their children.*

The main idea of this paper is that transfers are a way to buy the elderly out of the labor force. The reason why societies may want to do such a thing is that output per capita is higher if the elderly do not work, even though the private marginal product of an old worker (and therefore his/her spot market wage rate) may be positive. In other words, transfers are a way to achieve higher economic efficiency, a way to achieve Osler's controversial objective.

I model this idea through externalities in the average stock of human capital. Like Lucas (1988), I use a production function where people's productivities depend not only on their own ability (whether inherited or acquired at a younger age), but also on the ability of the people surrounding them. Because the externality is on the *average* level human capital, a worker with lower than average skill lowers the average skill in his environment and has a negative effect on the rest of the workers.

And the rest of the story is simple: it is an unfortunate yet hardly disputable fact that human skills (both physical and mental) depreciate with the passage of time. Kotlikoff and Gokhale (1992) find that both male and female productivity reaches a peak at around age 45 and declines afterwards. Productivity at age 65 is less than 1/3 of the peak. Hence, old workers have lower than average skill and, consequently, exert a negative externality on the rest of the labor force. If the externality is important enough, aggregate output will be larger if the elderly do not work. **Transfers in this context are just the payments received by the elderly in exchange for their jobs.**

The idea of social security providing economic efficiency is not new. In fact, the very people who debated over the desirability of introducing Social Security in the United States during the twenties and thirties did not have only 'redistribution' in mind: they were also thinking about 'efficiency'. Barbara Armstrong, a Berkeley Law professor and member of the Committee on Social Security appointed by the President in 1934 to draft the Social Security Act, had no doubt that old–age social security was conceived with retirement in mind. Roosevelt, she says, had to choose between keeping older workers in jobs and creating opportunities for youth: *"The interest of Mr. Roosevelt was with the younger man...That is why that little ridiculous amount of $15 was put in. Let [the elderly] earn some pin money, but it had to be on retirement. And retirement means that you've stopped working for pay"*.[5]

The word 'efficiency', however, does not appear in the final text of the Act. One of the reasons is that in 1934, the Supreme Court ruled that forcing people to retire for age reasons in order to achieve economic efficiency represented age discrimination and was therefore unconstitutional.[6] Of course other reasons why the

---

[5]Barbara Armstrong Memoirs, Columbia University. Another thing that was in the minds of the founders was that social security would be a way to redistribute the limited amount of jobs available. In other words, it is a way to introduce job sharing. Presumably, they thought that younger people were more productive and, therefore, it would be better for the economy if the younger people occupied the jobs. In a way this is also an efficiency argument. The question is why didn't private firms fire the elderly and hire the unemployed young workers at the same wage rate, thereby increasing overall profits in the first place?. I suppose that the answer would come from the assumption that firms are paternalistic and have a hard time firing old people after many years of work (Graebner (1980)).

Some people think that, because unemployment is not as important as it was during the Great Depression, job sharing has become an obsolete goal of the Social Security program (see Feldstein (1977)).

[6]*Railroad Retirement Board versus Alton Railroad*. The dispute was over the 1934 Railroad Retirement Act introduced by Senator Robert F. Wagner of New York. The 1935 Social Security Act was also challenged on the same grounds. In 1937 the Supreme Court found it to be constitutional.

final Act does not talk about efficiency is that saying things like 'we should get rid of workers above 65 because they interfere with the normal functioning of the economic system' are not politically attractive, as Dr. Osler found out after his 1905 valedictory address. Even thought the end result was the same, the political packaging of the Act as 'All Americans are now assured the possibility to retire. To begin a new, happy life. The golden age when they will enjoy the much deserved opportunity to go places and do things, the very things they always dreamed of, but could never do' was more appealing. For some reason altruism and redistribution seem to sell politically a lot better than efficiency. Of course it is much easier to be altruistic towards strangers when you can do it for free, or for a profit.

Because the text of the Social Security Act calls for the Federal Government being at last charged with the obligation to provide its citizens a measure of protection from the hazards of life, and because Roosevelt and the other politicians behind it have been seen as such great humanitarians, Bogart–type cool–exterior–warm–hearted individuals, the real motivation behind social security is never questioned. We are so used to the institution of retirement, so attached to the written spirit of the Social Security Act, that we have taken it as an act of faith that its *stated purpose* is its *real purpose*. And with this assumption behind, economic researchers have asked whether the form of financing increases or decreases savings, how social security programs affect labor market incentives, what will happen when the elderly outnumber the young, or whether it should be fully funded or pay–as–you–go (PAYG) (see for instance the collections of papers in Boskin (1978a and b), and Campbell (1977) and (1978). See also Barro (1978), Feldstein (1978), Pechman, Aaron and Taussig (1968) and Diamond (1977)). When asking about the reasons behind the existence of pensions, people talk about imperfect financial markets (such as inability to diversify risk, incomplete insurance markets and adverse selection problems) and/or individual irrationality together with a

paternalistic government to ensure that individuals have enough income when they retire (see Diamond (1977), Feldstein (1977) or Merton (1983)). Browning (1979) and Vergara (1990) provide a public choice approach where people know that the government will take care of them when they end up being poor so they choose not to save when young. Kotlikoff (1987) shows that social security arises as people who care for each other try to free ride on each other's utility (ie, if I know that you will take care of me if I am poor, I will not save when young). Finally, political scientists argue that social security systems arise as the elderly achieve a majority and vote themselves a big transfer.

All these theories completely assume that the elderly retire[7] and, by doing so, they don't analyze what I believe is the key point: old–age pensions could be **designed** to buy the elderly out of their jobs. If this was the case, transfers and retirement would be the two faces of the same coin.[8]

The rest of the paper is organized as follows. In Section 1 I present some facts about social security programs around the world. In section 2 I introduce the model. Next I study the steady state behavior of the economy and analyze the conditions under which economies will choose to introduce a social security system. In section 4 I deal with the transition and explain why economies will introduce social security as they reach a certain level of income. In section 5 I allow for changes in the population structure and show that when life expectancy increases the

---

[7]For example, one could solve the commitment, irrationality and free–rider problems by sending the clever free riders back to work for fifteen more years. Of course in the papers mentioned above this is never a possibility since retirement is an unquestioned given around which the theory is built.

[8]Acknowledging that pensions reduce the work incentives of the elderly, some researchers call this an 'unintended and damaging effect of social security'. Pechman, Aaron and Taussig (1968) write: "Payment of early retirement benefits has proved **unsatisfactory** for two reasons: first, it causes low benefits to be paid to very needy aged persons; **second it is still another aspect of the social security system that reduces the work incentives of the aged**" (p.148). They go on to describe policies to get rid of this undesirable feature of the system.

desirability of social security increases and that when the dependency ratio increases, the desirability of a social security system is reduced. In the final section I conclude and propose some extensions.

(1) Social Security Systems Around the World. Some Facts.

(1a) Social Security is like a luxury good.

The first modern country to introduce the kind of welfare programs to which we have been accustomed was the German Empire under the leadership of the "iron chancellor" Otto Von Bismark. Welfare programs and old–age pensions were created in 1881 and 1889 respectively. Since then, social security programs have mushroomed all over the globe. Great Britain's Old Age Pensions act was enacted in 1908 and the National Insurance Act in 1911. These initial programs were just an extension of the previous poor laws. Its current form is based on the reform that followed the Beveridge Report in 1942 (see Hemming and Kay (1982)). Sweden enacted compulsory old–age pensions in 1915 (Stahl (1982)) and Switzerland in 1925 (Janssen and Muller (1982)). In the United States, the Social Security Act was enacted in 1935. By 1940, 33 countries had some kind of old–age social security program. By 1958 the number of countries was 80 and by 1979, 123. The number in 1989 was 130 (see Table 1 columns A and B for information on what was the year when the first old–age social security legislation was enacted and what is the latest piece of legislation in each country).

The fact that the history of social security systems is fairly recent suggests that these programs are introduced only after a certain level of development (or income) has been reached. This is certainly not true for other components of government

spending such as defense, police or imperial palaces[9]. Thus, public transfers appear to be what economists call a luxury good.

One way to asses the relation between social security and the level of development is to look at the cross country correlation between the log of income per capita and the log of social security transfers as a share of GDP for a cross section of countries. In Figure 1 I plot these two variables for 1970[10]. The positive association can be captured by the naked eye (correlation=.7). The regression coefficient is 1.08 (s.e.=.14) which implies that a 1% increase in income per capita increases social security transfers by about 2.08%.

Of course the positive association between transfers and income could reflect that rich countries tend to have older population. I calculated the number of people older than 60 years of age in 1970 as a fraction of total population and added it to a regression. The coefficient on fraction of old people is strongly significant (coef.=15.74 s.e.=3.70) but the coefficient on log of income per capita is also significant (coef.=.406 s.e.=.202). Hence, holding constant the number of old people as a fraction of total population, a 1% increase in income per capita increases transfers by 1.406%.

The reason why the fraction of old population is not enough to explain the luxury good property of transfers is explained by the fact that in most industrial nations, the system is universal in that all employed are covered by the program

---

[9]Even public entertainment seems to have priority over transfer programs. The Roman circus is an early example of that. Of course neither the gladiators (who were often slaves) nor the Christians that performed with the lions charged very high fees for their appearences. The lions themselves were purposely starved so they would be more ferocious at the time of the show (so the food expenses were also very small). It is , therefore, entirely possible that publicly provided entertainment represented a very small, almost negligible fraction of the Caesar's budget (the exact figures seem to have been lost in the annals of history so we can only conjecture...)

[10]The income data come from Summers and Heston (1988). The transfer data are taken from Government Financial Statistics (various issues) and are the average of social security transfers as a fraction of GDP over the period 1970–1985. This is the variable SOCSEC in the Barro–Wolf (1991) data set.

(agricultural workers and self employed individuals seem to be an exception in a lot of countries). Yet in developing countries, social security programs are often token programs where only a minority of workers employed in a few selected sectors or regions are covered. Table 1, Column C reports what sectors were covered in each country in 1989. See also Burgess and Stern (1989), Mesa-Lago (1978), Ahmad (1991), Mackenzie (1991), and the papers in Ahmad et al (1989) for evidence on this).

(1b) Transfers are Linked to Retirement.

In order to collect old age pensions in most countries, the elderly must show that they do not get labor income from any other source. In other words, they must effectively retire. In some countries (or sectors) retirement is mandatory in that people cannot choose to work at any wage rate (this was true, for instance in the U.S. public sector before the amendment to the Age Discrimination in Employment Act abolished mandatory retirement). Column D in Table 1 asks whether full retirement is necessary in order to collect pensions. We find that for 70 out of 108 countries where this information is available, retirement is necessary (column F shows the retirement age).

In most of the countries where retirement is not mandatory, the social security program provides strong economic incentive not to do so (column E in Table 1 shows that Australia, Canada, Japan, New Zealand, the United Kingdom and the United States provide such economic incentives) . In the United States, for example, retirement is not mandatory but marginal tax rates on labor income over $7,440 for retirees under 65 is 50% (these are 1992 figures). The marginal tax rate between 65 and 70 is 30%. Note that I said *labor* income: a person can be earning a million dollars a year in dividend income and receive a full retirement pension. But if he receives more than $7,440 a year in labor income, he will be taxed one dollar for

every two dollars earned. This of course introduces a distortion that reduces a person's willingness to work after a certain age. There is substantial amount of evidence showing that this is in fact the outcome of the social security program (Pechman, Aaron and Taussig (1968) chapter VI, Boskin (1986), Boskin and Shoven (1987) and Kotlikoff and Wise (1987)).

In summary, social security programs do not seem to want to take care of the elderly *as long as they have no income* but, rather, *as long as they don't work!.*

(1c) Pensions are linked to previous wages.

In most social security programs, a worker's earnings determine, in full or in part, his benefits. In some countries the benefits are just proportional to the contributions. In other countries the relation is not as clear. Some of them (Canada, Denmark, Finland, Iceland, Japan, New Zealand, Norway, and Sweden are examples of this) have two or even several tiers: A basic pension scheme, usually unrelated to previous contributions, provides a minimum amount of income for all the elderly. This basic tier acts as a welfare program much in the same way that British poor laws provided poor people with a minimum subsistence level of income. A second tier relates the pension benefits to the history of previous wage earnings. Column F in Table 1 shows that, for 130 out of 139 countries where information is available, the pension a person receives is linked to his previous wage history.

(1d) Pensions are linked to work history.

Before being able to collect pensions, people have to have worked (and contributed to the system) for a while. For virtually all countries, the pension received is related to the number of years of contribution (Table 1, Column H). The exact requirement to collect full pensions varies from country to country and it ranges from 3 years in Norway, Sweden, and the United Kingdom to 40 years in

Belgium.

(1e) Social Security programs enjoy a great deal of political support.

A Gallup poll taken in December 1935 found that 89% of the population supported the Mandatory Old Age Pension System introduced just a few months earlier. The support increased to 93% by July 1941 and 96% by August 1944. Among the people who did not support the program in 1935, 24% did not do it because 'congress will spend the money on something else before the people get any benefit' (see Schiltz (1965)). The Social Security Program, therefore, has enjoyed widespread support since its very inception.

Of course the popularity of the system can be inferred from the absence of alert politicians making 'the destruction of the pension system' an issue in an electoral campaign. It has been argued that one of the reasons Barry Goldwater lost the 1964 election to Lyndon Johnson is his reform proposal of the social security program.

(1f) Financed with wage taxes.

Column I in Table 1 shows that, in almost all countries in the world, the Social Security Program is financed with wage taxes. The worker generally pays a fraction and the firm pays the rest (although in some countries the government pays a final fraction).

(1g) Not related to political system.

Pension programs seem to appear in democratic countries as much as they do in non democratic ones. The very first program was created in Emperor William's autocratic German state in the 1880s. Other examples of non democratic countries that created such programs are Lenin's USSR in 1922, King Alfonso XIII's Spain in

1919, Emperor Ito's Japan in 1941, or Kuwait in 1976. Populist governments include Argentina under General Peron in 1946 and Mexico under General Avila–Camacho in 1943. Democratic examples are the United Kingdom in 1908, Sweden in 1913, the United States in 1935 or France in 1942.

(2) The Model.

(2a) Firms

Firm j employs N_t^j workers during period t. Each worker has a different level of skill or *human capital*. I will think of a worker of skill h^{ij} as being h^{ij} times more productive than a worker of skill 1. There are n_t^{ij} people with a level of skill h_t^{ij}. The effective amount of labor in firm j is therefore $H_t^j = \sum_i n_t^{ij} h_t^{ij}$ (note that the number of workers –bodies with different skill levels– is $N_t^j = \sum_i n_t^{ij}$). The production possibilities of a firm at time t can be described by a neoclassical production function amended by two human capital externality factors:

$$(1) \qquad Y_t^j = A \cdot K_t^{j^a} \cdot H_t^{j^{1-a}} \cdot (H_t^j/N_t^j)^{\epsilon_j} \cdot (H_t/N_t)^{\epsilon}$$

where Y_t^j is output, K_t^j is the stock of physical capital, A is a parameter that reflects the level of technology, H_t is the aggregate level of human capital or skill–weighted labor and N_t is the aggregate level of employment. The term $(H_t^j/N_t^j)^{\epsilon_j}$ reflects an 'externality'[11] from the average human capital of the firm's

---

[11]I call this an 'externality' because it represents an effect from one worker's productivity on other worker's productivity. Hence, it is an effect external to the worker, even though it is not external to the firm. Some people would argue that, as long as these cross–person effects are not important across firms, this is not really an externality. Maybe they would prefer the name 'internality' but since this word

workers on its own workers. In other words, the marginal contribution of a worker of quality h^{ij} to the output of firm j is the sum of his "private" productivity plus his contribution to the average level of human capital, which in turn, affects everybody else's productivity. This reflects the social interaction of workers within the firm. Note that the production function (1) is homogeneous of degree one in workers and physical capital (holding constant aggregate variables). The term $(H_t/N_t)^\epsilon$ reflects a similar externality from the *average* level of human capital of the economy. I call it an inter–firm externality.

These externalities capture the type of social interactions among workers within as well as across firms which has been emphasized by Lucas (1988). Social interaction is an important part of everyday work: co–workers exchange ideas and learn from each other. People meet in seminars, conventions and national meetings and also exchange ideas and learn from each other. Japanese workers spend some time after work drinking with their colleagues and with workers of other firms. They claim that this enables them to develop informational networks that makes them more productive at work.

If workers are in contact with high quality people, their own productivity is larger. The productivity of a worker depends on the quality or human capital of the average person he happens to encounter in his work environment (which includes people working in other firms). The productivity of a particular engineer or economics professor would improve if, during the next twenty years, the best students in the best colleges decided to become engineers or economics professors rather than lawyers. Of course the people who would benefit most from these superstars would be their co–workers, but professors at other universities would also benefit from having the smartest people as part of their profession.

---

has net yet been created, I will keep calling it 'externality'.

Jacobs (1969) provides a number of examples showing that social interaction is not only important in professions such as academics or the arts but in many other occupations as well. As Lucas puts it, *"...much of economic life is 'creative' much in the same way as 'art' and 'science'. New York City's garment district, financial district, diamond district, advertising district and many more are as much intellectual centers as Columbia or New York University. The specific ideas being exchanged in these centers differ, of course, from those exchanged in academic circles, but the process is much the same. To an outsider, it even looks the same: A collection of people doing pretty much the same thing, each emphasizing his own originality and uniqueness".*

I should say that externalities from the average quality of the labor force do not necessarily need to reflect social interaction. Following Arrow (1962) consider jobs where there is learning by doing by workers and where the things learnt in one firm spill over into other firms (see Jaffe (1986) for evidence on this type of spillovers). Suppose that every time a worker sees an idea invented or improved by somebody else, he must try it for a while. If it turns out that it is a good idea, he adopts it and thus becomes more productive thereafter. If it turns out to be a bad idea, he will have wasted some time trying it. Since he cannot sort out good from bad ideas beforehand, he will have to try a number of them before he comes up with a good one. Suppose finally that better people have a larger proportion of their ideas being good. It follows that lower than average people will tend to exert a negative influence on the rest of the labor force as their ideas will tend to be bad on average. The same type of framework would apply to economics professors who read, referee, discuss and maybe learn from papers written by other economists (most of the time we do not know the person who writes the paper so we cannot sort out good from bad ideas before we invest some time in reading the paper). It also applies to most of the professions where ideas flow from worker to worker, or to

Japanese workers who exchange information while drinking sake in a sushi bar.

Lucas claims that these externalities are the force pulling cities together: *"why can people be paying Manhattan or downtown Chicago rents for, if not for being near people?"*. Furthermore, they are the reason why rich countries have higher wages for every level of human capital, which explains why there is a tendency for people to migrate from poor to rich countries. The externalities I am considering here are probably not economy–wide but, rather, sector–specific (or maybe externalities across similar sectors (see Jaffe (1986)). In the one–sector aggregative economy in this paper, however, the two would coincide (for my story to work, however, I do not need the externalities to be economy–wide). The way I set up this economy, I am not only assuming that human interaction in production generates externalities, but also that these externalities cannot be avoided.

I assume that there are only two types of people in this economy: young and old. At time t, there are n_t^y young people with a skill level h_t^y and n_t^o old with a skill level h_t^o. If all firms are identical, the production function in (1) can be written as

$$(2) \quad Y_t^{all} = AK_t^a \cdot (n_t^y h_t^y + n_t^o h_t^o)^{1-a} \cdot [(n_t^y h_t^y + n_t^o h_t^o)/N_t]^{\epsilon j} \cdot [(n_t^y h_t^y + n_t^o h_t^o)/N_t]^{\epsilon}$$

where, again, I assume that all young and old people work (the superscript j has been omitted from 2). Y^{all} stands for output produced when ALL workers are employed (as opposed to output produced when only the young workers are employed, as it will be the case when I discuss economies with social security later on). Competitive firms choose the amount of workers of each type and the amount of investment in physical capital so as to maximize profits taking the last term (inter–firm externality) and input rental prices as given. The first–order conditions

entail the equalization of input rental prices to private marginal products

$$(3a) \quad w^{o,all} = \partial Y^{all}/\partial n^o = (1-a)\frac{h^o \; Y^{all}}{(n^o h^o + n^y h^y)} + \epsilon_j \cdot Y^{all} \cdot \frac{n^y \cdot [h^o - h^y]}{(n^o + n^y)(n^o h^o + n^y h^y)}$$

$$(3b) \quad w^{y,all} = \partial Y^{all}/\partial n^y = (1-a)\frac{h^y \; Y^{all}}{(n^o h^o + n^y h^y)} + \epsilon_j \cdot Y^{all} \cdot \frac{n^o \cdot [h^y - h^o]}{(n^o + n^y)(n^o h^o + n^y h^y)}$$

$$(3c) \quad r^{all} = \partial Y/\partial K = a\frac{Y^{all}}{K}$$

where I omitted time subscripts to simplify notation. The firm internalizes the intra–firm externality in that wages reflect not only the direct contribution of a worker to the firm's output (this is the first term in (3a) and (3b)) but also his effect on the productivity of the other workers of the firm through his contribution to the average human capital (second term in (3a) and (3b)). An important thing to note is that if the human capital of the old person is lower than that of a young, the wage rate the old will receive will be lower in the presence of externalities ($\epsilon_j > 0$). The opposite is true for young workers, whose skill is above average. The intuition is that when a firm hires a person with lower than average skill, there is a reduction in that firm's average skill and a consequent reduction in everybody's productivity. Firms internalize this 'externality' by lowering that person's wage rate. Note that if the difference between h^y and h^o is large enough and the externality is large enough, it is conceivable that an old person's overall productivity be zero or even negative. A profit maximizing firm would not like to hire that person at any positive wage rate. Note that the payment of inputs exhausts final output, $Y^{all} = rK + w^o n^o + w^y n^y$.

Firms, on the other hand, do not internalize the inter–firm externality so the

effect of a person working for firm j on the workers of all other firms ends up not being reflected on the wage rate firm j pays him. The social marginal products of old and young workers are

$$\partial Y^{all}/\partial n^o_{social} = (1-a)\cdot\frac{h^o\cdot Y^{all}}{(n^o h^o + n^y h^y)} + (\epsilon_j + \epsilon)\cdot Y^{all}\cdot\frac{n^y\,[h^o - h^y]}{(n^o + n^y)\,(n^o h^o + n^y h^y)}$$

and

$$\partial Y^{all}/\partial n^y_{social} = (1-a)\cdot\frac{h^y\cdot Y^{all}}{(n^o h^o + n^y h^y)} + (\epsilon_j + \epsilon)\cdot Y^{all}\cdot\frac{n^o\,[h^y - h^o]}{(n^o + n^y)\,(n^o h^o + n^y h^y)}$$

Note that the difference between the **social** and the **private** marginal products is that the second term in the social involves $\epsilon_j + \epsilon$ rather than ϵ_j. If the elderly have lower human capital than the young, their social marginal product will be lower than their private product if the inter–firm externality is positive ($\epsilon > 0$). Furthermore, if the inter–firm externality is large enough and the difference between young and old ($h^y - h^o$) is large enough, the social marginal product of labor of an old worker may be negative, even though his private marginal product is positive. *In other words, there exists the possibility that societies do not want the elderly to work, despite the fact that profit maximizing firms are willing to pay positive wage rates for their services.*

(2b) An Economy with Social Security.

Consider an alternative economy where the young people work and the elderly retire. The production function (2) can be rewritten as

$$(2)' \qquad Y^{ss}_t = AK^a_t\cdot(n^y_t h^y_t)^{1-a}\cdot[n^y_t h^y_t/n^y_t]^{\epsilon_j}\cdot[n^y_t h^y_t/n^y_t]^{\epsilon}$$

where "Y^{SS}" stands for Social Security. Note that the only difference between (2) and (2)' is that n^o has been set to zero in (2)'. The wage rate for the young in the social security economy is given by

$$(3)' \qquad w_t^{y,SS} = \partial Y_t^{SS}/\partial n_t^y = (1-a) \cdot \frac{Y^{SS} \cdot h^y}{n^y}$$

The key point here is that the externality parameters disappear from the wage rate. The reason is that when only the young people work, all employed have the average level of skill and, therefore, nobody affects the rest of the workers in a negative (or positive) way. The externality is relevant only if there are workers with different levels of skill.

(2c) Human Capital over the life cycle.

Most of the human capital literature studies how individuals allocate their time over various activities so as to increase their skills or human capital in the manner that maximizes their lifetime utility (Becker (1957), Rosen (1976)). Some authors study how the incentives to accumulate skills affect aggregate economic growth (Uzawa (1965), or Lucas (1988)). As noted earlier, Kotlikoff and Gokhale (1992) show that the skill–age profile for the typical worker is an inverse–u shape with a maximum at approximately 45 years of age. A typical age–skill profile is depicted in Figure 2. In this paper I am most interested in the effects of the inevitable decline in human capital that accompanies the passage of time. That is, I want to concentrate in the downward–sloping section of the skill–age profile. Therefore, and in order to keep the model as simple as possible, I will neglect the early stages of life when individuals accumulate skills both through the allocation of time to study and learning through experience at work (learning by doing). I will simply assume

that a young person born at t+1 inherits the human capital that his parents had when he was young, augmented by some growth factor γ

$$(4) \qquad\qquad h^y_{t+1}=(1+\gamma)h^y_t.$$

The growth factor is similar to the one postulated in the old neoclassical literature. It reflects the improvement in training methods as well as technological progress. Implicitly I am assuming that these technological improvements more than offset the human capital depreciation that occurs due to the imperfect transmission of skills from parents to children. The growth rate γ could be modeled as an exogenous constant or, following Romer (1990) and Grossman and Helpman (1991), it could be an increasing function of the level of human capital:

$$\gamma(h^y),$$

where $\gamma'(h^y)$. This result reflects the fact that technological innovations are made by researchers of quality h^y and the better the quality of the researchers, the larger the rate of technological progress.

The growth rate could also reflect the effects of investment in education while young. For the sake of simplicity, I prefer to take γ as given and use a two generation overlapping generations model than to use a three generation model where babies choose the level of investment in education during the initial period of life. As is well known (Buiter and Kletzer (1991)), the endogenous growth of human capital would depend on the 'learning technology' available to educate people, on the willingness to substitute over time, on the rate of temporal impatience and human capital depreciation rates. As will be apparent later on, the main lessons from this paper do not depend on whether growth is exogenous or endogenous.

The abstraction from the 'learning age' implies that a young person in my model represents a worker at the peak of his career. In order to reflect the loss of human capital due to the passage of time, I assume that if an agent's skill level is h_t^y when young, his skill when old will be

$$(5) \qquad h_{t+1}^o = (1 - \delta(h_t^y)) \, h_t^y$$

where $\delta(h_t^y)$ is the rate of human capital depreciation. I assume that $\delta'() > 0$ and $\lim_{h^y \to \infty} = \bar{\delta}$ were $\bar{\delta}$ is the upper bound on the rate of depreciation which may or may not be equal to one. The assumption of increasing depreciation rates is based on two arguments. First, theoretically, most people's skills are linked to the technology available at the time when they learnt. Like physical capital, human capital is vintage– or technology–specific. The reason is that it is hard for old people to learn new technologies: old secretaries find it difficult to learn modern computer techniques, old professors have a hard time learning new theories and tools, old salesmen cannot cope with new sales methods.[12] When technological progress occurs, the skill embodied in existing workers suffers economic depreciation: since their skills are linked to the previous technological environment, they become obsolete. Of course the larger the rate of technological progress, the larger the rate of human capital depreciation. It follows that $\delta = \delta(\gamma)$ where $\delta'() \geq 0$. If, as in Romer (1990) and Grossman and Helpman (1991), technological progress is positively related to the stock of human capital ($\gamma = \gamma(h^y)$ with $\gamma' \geq 0$), the effective depreciation rate of human capital is a function of the level of human capital. In other words, rich economies

---

[12]In talking about the problems of the American University, Osler thought that the problem with old professors was not their loss of judgment or memory. He argued that *"the change is seen in a weakened receptivity and in an inability to adapt oneself to an altered intellectual environment. It is this loss of mental elasticity which makes them so slow to receive new truths"* (Osler (1910)).

are rapidly changing economies where the skills of a person suffer quick economic obsolescence.

Second, empirically, the variance of skills across people at the peak of their careers is proportionally larger than that at much older ages. Mincer (1974) regresses wages on a bunch of explanatory variables (excluding ability) and finds that the variance of the residuals (which he interprets as the variance of ability) is positively related to experience for the first 25 years, and negatively afterwards. Glaeser (1992) Figure 2 provides similar evidence (and an alternative interpretation) using more recent data. Thus, people who had larger skill at age 45 had lost proportionally more of their skills by age 65.[13] It follows that the depreciation rate is an increasing function of the level of skill. A functional form I will use in the numerical simulations later on is $\delta(h)=\bar{\delta}(1-e^{-\tau h^y})$, where τ is some constant number that reflects the speed at which depreciation reaches its maximum value $\bar{\delta}$ as human capital increases (see Figure 3).

Since I am considering only two generations, we should think of $\delta()$ as the depreciation rate over a period of approximately 25 years.[14] Kotlikoff and Gokhale (1992) document that human capital increases with age over the first 45 years of life and declines to about a third of that by age 65. They find to be true for males and females, for office workers, sales workers, and managers alike. Hence, depreciation rates of 2/3 for 25 years do not seem unreasonable.

---

[13]This is true if the residuals represent the log of ability. It is hard to see, however, what function of ability these residuals really are.

[14]Correspondingly, the growth rates γ also refer to 25 year periods.

(2d) Consumers.

Because I want to explain the existence of transfers within a Ricardian world, I follow Barro (1974) and model individual agents as caring about their own lifetime utility and about that of their children. Hence, the utility function of a person born at t is

$$(6) \qquad V_t = u(c_t^y) + (1+\rho)^{-1}u(c_t^o) + (1+\psi)^{-1}V_{t+1}$$

where ρ and ψ are the rates at which an individual agent discounts his own future utility that of his children respectively. An agent born in period t receives a positive bequest b_t from his parents. While young, he works at a wage rate w_t^y. If society chooses to introduce a social security system, then the young worker will be taxed a fraction τ of his wage[15]. He allocates his resources between consumption c_t^y and assets s_{t+1}^y. At the end of youth (or the beginning of old age) he has n children, each of whom he endows with a bequest b_{t+1}. He receives interest on the assets he saved when young $s_{t+1}^y(1+r_{t+1})$ as well as a wage w_{t+1}^o for his work while old. If a social security system has been introduced he may not work when old. He may receive pension T_{t+1} instead. He consumes c_{t+1}^o. His budget constraints are therefore:

$$(7) \qquad c_t^y + s_{t+1}^y = w_t^y(1-\tau) + b_t$$
$$c_{t+1}^o + (1+n)b_{t+1} = w_{t+1}^o + T_{t+1} + s_{t+1}^y(1+r_{t+1})$$

The government budget constraint depends on whether the social security

---

[15]Almost all social security systems that exist and have existed on planet earth get their resources through wage taxes. See Column I in Table 1.

system is Pay As You Go (PAYG) or Fully Funded. If it is PAYG, then at time t

the government just collects taxes from the young ($\tau > 0$) and gives them to the old:

$\tau \cdot w_t^y \cdot (1+n) = T_t$.[16] If we add up the constraint for all the people alive at time t

we get

$$(8) \qquad C_t + S_{t+1} - S_t = W_t^y + W_t^o + r_t S_t$$

where C_t is total consumption, S_t is the total amount of financial assets in period t,

and W_t^y and W_t^o are the total wage bills for young and old respectively (W_t^o will be

zero if the elderly retire). The economy is closed to foreign financial and goods

markets so aggregate savings equal aggregate investment. The only asset in this

economy is physical capital so $S_t = K_t$ for all t. Using the first order conditions for

the firm (equations 3), the right hand side of (8) is total output. Equation (8) says

therefore that consumption plus investment equals total GDP. The first order

conditions are

$$(9) \qquad u'(c_{t+1}^y) = u'(c_{t+1}^o)(1+\psi)/(1+\rho)$$
$$u'(c_t^y) = u'(c_{t+1}^o)(1+r_t)/(1+\rho)$$

where I assume that $b_t > 0$ for all t. Again, this assumption is made so as to get the

Ricardian Equivalence result. For simplicity, I have assumed zero population growth,

n=0 (in section (5) I analyze changes in the population structure). In order to get

closed form policy functions I consider the case of logarithmic utility, full

depreciation of physical capital. Furthermore I assume that $\rho = \psi$, that is, the rate at

---

[16]A fully funded social security system would require agents to buy τw_t^y units of

asset A_{t+1} when young and would refund $\tau w_t^y (1+r_{t+1})$ when old.

which we discount our children is the same as the rate at which we discount our own future[17]. The resulting policy function for investment is

$$(10) \qquad\qquad K_{t+1} = aY_t/(1+\rho)$$

where the first order conditions for firms have been used. This policy function says that savings (and investment) are a constant fraction of total GDP. Using (10), the output path for an economy where all people work is described by the following difference equation

$$(11)\, \ln Y_{t+1}^{all} = \eta + a\ln Y_t^{all} + (1-a+\epsilon_j+\epsilon)\ln(n_{t+1}^y h_{t+1}^y + n_{t+1}^o h_{t+1}^o) - (\epsilon_j+\epsilon)\ln(n_{t+1}^y + n_{t+1}^o)$$

where $\eta = a\ln(a/(1+\rho))$ is an unessential constant. The initial condition needed to solve this difference equation is the initial capital stock, K_0. Using the policy function (10), the path of aggregate output is described by the difference equation

$$(12)\ \ln Y_{t+1}^{SS} = \eta + a\ln Y_t^{SS} + (1-a+\epsilon_j+\epsilon)\ln(n_{t+1}^y h_{t+1}^y) - (\epsilon_j+\epsilon)\ln(n_{t+1}^y)$$

where η is the same unessential constant as in (11) and the initial condition is given by K_0.

---

[17]This later assumption is not necessary and it does not introduce too much additional complication. The main simplication is that $c_t^y = c_t^o$.

(3) Desirability of Social Security in The Steady State.

Define the steady state as the state where all variables grow at a constant rate. The policy function (10) says that in the steady state, physical capital and output grow at the same rate. The level of human capital for all workers grows at rate γ and its depreciation rate is at its maximum possible value, $\bar{\delta}$. Using (11) and the behavioral equations for human capital (4) and (5), the steady state growth rate of the economy where all people work is

$$(14) \qquad \left(\gamma_Y^{all}\right)^* = \frac{1-a+\epsilon_j+\epsilon}{1-a} \cdot \gamma$$

If there were no externalities ($\epsilon_j=\epsilon=0$), the growth rate of output would be equal to the (exogenous) growth rate of human capital, γ. The steady state growth rate of output of the economy with social security is

$$(15) \qquad \left(\gamma_Y^{SS}\right)^* = \frac{1-a+\epsilon_j+\epsilon}{1-a} \cdot \gamma$$

Note that $\left(\gamma_Y^{all}\right)^*=\left(\gamma_Y^{SS}\right)^*$, so whether the elderly work or not does not affect the steady state growth rate of output. The reason is that, in steady state, the relevant depreciation rate is constant and therefore the stock of human capital of the young and the old grow at the same rate. It follows that the effective labor and the marginal product of physical capital also grow at the same rate in both economies, so final output must also grow at the same rate.

Consider two economies in the steady state. Imagine that, at time t, they have the same amount of inputs. The difference is that in one economy everybody works. In the other, the elderly retire. Since, as we just showed, the growth rates

in both economies will be the same, then the steady state difference in the log of output is constant and equal to

$$(16) \quad [\ln(Y_t^{all}) - \ln(Y_t^{ss})]^* = \frac{1-a+\epsilon_j+\epsilon}{1-a} \cdot \ln\left[\frac{n^0}{n^y} \cdot \frac{1-\bar{\delta}}{1+\gamma} + 1\right] - \frac{\epsilon_j+\epsilon}{1-a} \cdot \ln\left[1 + \frac{n^0}{n^y}\right]$$

Equation (16) suggests that if there are no externalities ($\epsilon_j = \epsilon = 0$), the steady state level of output is always larger in the economy where all work. It also says that if the externalities ($\epsilon_j > 0$ and/or $\epsilon > 0$) and the limiting depreciation rate, $\bar{\delta}$ (which determines the gap between h^y and h^0) are large enough, the total output in the economy where all work is lower than the total output produced when the elderly retire. If this is the case, people in the economy where all work will find that everybody can get more output if they introduce a scheme by which the *elderly retire*. One way to achieve this outcome is to introduce a 100% or higher tax rate on the wage of the elderly (the tax rate should be 100% if the social marginal product of the elderly is zero and higher if it is negative). Another way to achieve the same goal is to give the elderly some income conditional on them not working. In other words, **one way to achieve a socially efficient outcome is to introduce a social security program by which the elderly receive a transfer from the young, conditional on retirement**:

$$(17) \quad T = \begin{bmatrix} TR & \text{if } n^0 = 0 \\ \sigma & \text{if } n^0 > 0 \end{bmatrix}$$

'where TR is the pension the elderly receive if they DO NOT WORK[18] and σ is the pension they receive if they do. σ could be zero or could be a small number (which would reflect a high marginal tax rate for labor income while collecting pensions). If TR is large enough, the elderly will optimally choose to retire. The exact amount of income required to buy the elderly out of their jobs (ie, the transfer that makes the elderly choose $n^o=0$) will depend on whether they like their jobs or not. If they are indifferent between working or not working (as they are in my model since they have no preference for leisure time), the required transfer would be the wage they would earn if they worked. That is, if they do not care about leisure, they will stop working if the income they receive retiring is at least as high as the income they receive if they work. If they work they receive $w^{o,all}+\sigma$. If they retire they receive TR. They will choose to retire if TR $\geq w^{o,all}+\sigma$. If they have a preference for leisure, the transfer would be smaller than the opportunity wage (TR$<w^{o,all}+\sigma$). If they like their jobs[19], then the required transfer would be above the opportunity wage.

It is interesting to note the existence of a 'surplus' income generated by the higher efficiency brought about by the retirement scheme: Imagine that the elderly retire and receive a transfer by the amount of the wage rate they would get if they worked (ie, TR$=w^{o,all}$). Imagine that the young also get the wage rate they would

---

[18]Note that in this simple model, the elderly must choose whether to work full time or retire fully. I do not allow for part-time jobs or other forms of partial retirement. An extension of the model would include a continuous leisure–work choice and the elderly would be able to choose the degree of retirement in response to the incentives provided by social security laws. The main point, however, would be the same: social security schemes introduce distortions in the relative prices of work and retirement leisure. The main substitution effect provides strong incentives for retirement. See Boskin (1986) for some evidence on the effect of social security on the work incentives of the elderly.

[19]It has been argued that some old people would like to keep their jobs after 65 Hockman (1950).

get if the elderly worked ($w^{y,ss}=w^{y,all}$). After rewarding the young, the old and the capital stock, there would be some extra output left due to the increase in efficiency brought about by the retirement of the inefficient elderly. That is

$$(18) \qquad Y^{ss} - \{w^{o,all} \cdot n^o + w^{y,all} \cdot n^y + r \cdot K\} = \text{Surplus} > 0$$

This surplus could be appropriated by the young, by the elderly, by the government, by the social security bureaucracy or by some combination of the four. My theory does not say who should appropriate this surplus. What the model predicts, however, is that if the elderly can appropriate a fraction of the surplus (as defined above), transfers as a fraction of GDP will increase over time. This is true even if the ratio of young to old people remains constant throughout. Of course if population was aging, the ratio of transfers to GNP would increase even more. This is interesting because this is a feature that we find in the data.

(3a) Private or Public Pensions?

An important question is whether these old–age pension–retirement schemes should be introduced by the government or by the market. The answer depends on what type of externality is important. In the case when retirement is desirable because $\epsilon > 0$ (inter–firm externality), a social security system would yield higher income for all players, yet private markets would not do the job because individual firms would be willing to pay positive wages for the elderly's services (their overall private marginal product is positive). Because their social contribution is negative, however, government intervention is necessary to introduce the social security system. Hence, the government will have to intervene and create old–age pensions to buy the

elderly out of their jobs.[20]

If retirement is desirable because $\epsilon_j > 0$ (intra–firm externality), the private marginal product of the elderly is negative so no firm has an incentive to hire them at positive wage rates. As people reach a certain age when their positive contribution to the firm's output no longer offsets the negative effect on their colleagues, firms will offer the elderly a negative wage rate (they have to pay a fee for working). Unless they really enjoy their jobs, the elderly will optimally choose to abandon them. The market therefore will do the job.

In a set of clever and original papers, Lazear (1979, 1983) outlined the reasons why mandatory retirement was beneficial: an increasing wage–age profile is an efficient way for firms to solve the agency problems vis-a-vis the workers. But if the wage–age profile is increasing, the marginal product of labor for people of age 65 is lower than the wage rate, and at this 'high' wage rate, the elderly will choose to keep working but the firm will like separation. Knowing this in advance, the firm will hire people with the understanding that the job will be terminated at 65. Mandatory retirement is, therefore, a good thing to have.

---

[20]I am assuming that the elderly cannot form a firm or a division where they can work without impairing the ability of the young. If this was a feasible alternative, the economy as a whole could produce more output by confining the elderly to these isolated jobs than with the social security program: when all workers are old, there are no negative externalities since everybody has the average human capital. Note that, to the extent that the externalities are across firms, what would be needed are jobs where the elderly do not interact with the youngsters of other firms.

One reason why we do not see firms with old people only may be that young workers are a necessary input of production. Another reason could be that it is very costly for people to adapt to new working environments. Hence, if given the choice to retire or work in a different company or division, they may choose to retire for any feasible transfer. In other words, the elderly will choose to change jobs only if they are fully compensated for the loss of utility associated with such a change. The social output gains from this alternative scheme may not be large enough for such compensation.

Finally, one could argue that **there are** 'elderly only' firms: In Japan, workers are assigned to a different divisions of the company as soon as they reach a certain age. In the United States, people are assigned to a completely different state called Florida.

In the introduction to his paper, Lazear rejects the view that the reason for old−age retirement is the reduction of productivity with age by arguing that this would not require retirement but rather a reduction of wages that equalizes them to these lower marginal products. Of course he had in mind a neoclassical production function. My model provides an alternative explanation for why firm may want workers to sign such contracts: the marginal product of labor may be zero or even negative at age 65. The main problem with Lazear's story is that, even though it can explain why private firms would like the elderly to retire, it does not explain why in most countries, it is the government that organizes large−scale social security programs that provide the incentives for retirement.

At the time Lazear wrote his paper in 1979, mandatory retirement in the United States was legal (at age 65). Since then, Congress has enacted legislation that extends the Age Discrimination in Employment Act by first delaying mandatory retirement until age 70 and then outlawing it altogether.

So let me take it as a given that mandatory retirement represents age discrimination and it is, therefore, illegal. Firms can still achieve the same outcome if they offer a private pension plan by which the young pay a fraction of their income and the elderly receive a transfer, **conditional on not working**. Every worker would receive the same present value of income over his lifetime, the firm would produce the same output and receive the same profits, and the scheme would be constitutional in that the elderly are not fired, but they 'optimally choose to retire'.

Obviously in the real world there could be both intra−firm and inter−firm externalities. If the former ones are not large enough to warrant private job termination, government intervention will be necessary.

I should mention at this point that this story is consistent with some of the social security facts mentioned in section 1. First, the link between transfers and retirement has already been explained. Second, the link to previous wages can be

explained if previous wages are a signal of the wage rate the person would receive at age 65 (which, recall, is the wage rate necessary to buy him out of the labor force). Of course one may want to introduce elements of fairness in the social security program, and those would also help explain why people who paid more into the system tend to get more out of it. The story of this paper, however, can explain a substantial fraction of the facts, without having to appeal to fairness. Third, the model is consistent with the linking of transfers to previous work history: there is no need to retire people who are not in the labor force. Fourth, the model explains why these programs enjoying great political support: everybody benefits from them. Of course this does not mean that, due to reasons outside the model, the bureaucracy administering social security cannot become too large and inefficient so that they offset the gains in efficiency. Finally, it explains why the creation of social security programs is unrelated to political systems. Under democracy, people will vote for such a system since they all gain from it. Under dictatorships (whether they are left– or right–wing) these programs will be introduced because they enlarge the size of the cake from which the dictator extracts his rents.

(4) The Transition: Endogenous Creation of Social Security.

Up to now I have showed that if the externality parameters and the human capital depreciation rates are large enough, the steady state level of income will be larger in the economy with social security. But in the real world we observe economies going from a system with no pensions to a system with pensions as they develop. In other words, if social security is so good, why didn't societies create them back in the middle ages?[21] Why are social security systems created only after

---

[21]Social insurance programs through history have usually been left to other institutions such as churches, families or villages. Government–sponsored social

a certain level of development has been reached?[22]

To answer these questions consider two economies that, at time zero, have the same level of physical capital, human capital, and number of people of both generations. In one economy everybody works and in the other, only the young work. The difference in (log) output between these two economies is given by

$$(19) \quad \ln(Y_0^{all}) - \ln(Y_0^{ss}) = \frac{1-a+\epsilon_j+\epsilon}{1-a} \cdot \ln\left[\frac{n^o}{n^y} \cdot \frac{1-\delta(h^y)}{1+\gamma}+1\right] - \frac{\epsilon_j+\epsilon}{1-a} \cdot \ln\left[1+\frac{n^o}{n^y}\right].$$

All the terms in equation (19) are equal to equation (16) with the exception of the depreciation rate inside the first log. In the steady state (equation 16) the relevant rate is $\bar{\delta}$. Out of the steady state (equation 19), the relevant rate is $\delta(h^y)$, where h^y is the level of human capital corresponding to the previous period. Since $\delta'() > 0$, it is possible to find sets of parameters for which $\ln(Y_0^{all}) > \ln(Y_0^{ss})$ but $\ln(Y^{all})^* < \ln(Y^{ss})^*$. In other words, it is possible that the social security economy produces more output in the steady state but, because at low levels of human capital the elderly do not really exert a negative externality on the young; output at low levels of income is higher in the economy where all work. **The model, therefore, is consistent with the endogenous creation of social security after a certain level of development has been reached.**

The transitional paths of aggregate output for the two economies are described by equations (11) and (12). We can solve for the time paths of the two economies numerically. In Figure 4 I report an example of such time paths. The path labeled $\ln(Y^{all})$ refers to the economy where all work and the one labeled $\ln(Y^{ss})$ corresponds to the economy with social security. The corresponding underlying

---

security schemes are fairly recent innovations (see discussion in section 1).

[22]Existing theories of transfers should also try to answer these questions.

parameters are the same, the only difference between these two economies is, therefore, that in Y^{ss} the elderly do not work.

Initially, the economy without social security produces more output. The reason is that at low levels of development, technologies do not change very rapidly and, therefore, the skills of the elderly are very similar to those of the young. During this period, therefore, society is likely to choose NOT to have social security programs. As human capital accumulates and technologies start to change more and more rapidly, the economic depreciation rate starts to increase thereby introducing an increasing gap between the human capital of the old and the young. The elderly start to be a burden on the young. There is a point in time $\hat{t}$, where the social product of the elderly becomes negative as the negative effect of the externality outweighs their positive private marginal product. After this point, the economy with social security will produce more output: people will think that maybe it would be good to introduce legislation to buy the elderly out of their jobs.[23] In Figure 5 I plot the difference between $\ln(Y^{all})$ and $\ln(Y^{ss})$. Note that after a period on the positive side, it becomes negative at time $\hat{t}$ and stays there forever: aggregate output is larger if the elderly do not work.

One prediction of the model is that, after social security is introduced, the economy will grow faster.[24] We can see in Figure 4 that at around the time when Y^{ss} is close to Y^{all}, the line $\ln Y^{ss}$ is steeper than $\ln Y^{all}$ (since the units are logs, the slopes are the growth rates of output). Hence, in a cross section regression, it

---

[23]Note that I abstracted from anticipation effects in that I assumed that agents in the economy where all work behaved as if they thought that social security was never going to be introduced. Of course the expectation of future implementation of social security will change individual behavior early on and the actual output path will change. The assumption is that people are fully surprised by the introduction of retirement and tranfers (ie, they assigned a zero probability to the introduction of pensions before they are created and assign a zero probability to their elimination after they are created).

[24]Assymptotically, however, the growth rate of the economy with social security economy will be the same as the economy without.

will appear as if transfers were productive.[25]   And in a way, they are since "buying the elderly out of their jobs" could be thought as an input of production that increases overall output.

(5) Changes in Population Structure.

Up to this point I have assumed a constant population structure. Most analyses in the literature link the introduction (and the desirability of a potential elimination) of social security systems to changes in the population structure. Increases in life expectancy are often seen as the key reason why social security schemes are first created. On the other hand, increases in the number of old relative to young are often seen as the key reason why social security programs, in their current form, will eventually collapse. In this section I want to explore the effects of changes in life expectancy and in the dependency ratio (ratio of the number of old to young people).[26]

(5a) Increase in Life Expectancy

In order to introduce changes in life expectancy in my simple model of two generations, let us go back to the original production function (1) where
$H_t^j = \sum_i n_t^{ij} h_t^{ij}$ and i runs from 0 to the oldest possible ages, $\hat{i}$. An increase in life expectancy works like an increase in $\hat{i}$. Of course for ages after the peak in human

---

[25]This assumes that all the economies in the data set are within a reasonable range of $\hat{t}$, the time at which social security is introduced.

[26]In the analysis above, I have assumed that the overall size of the population was constant. Inspection of the equations of motion shows that increases in the size of population that leave the same ratio of old to young people will have no effect on the dynamic paths of the economy (ie, n^y and n^o always enter in the analysis as a ratio). Hence, aggregate population growth is neutral and it adds no interesting features to the story.

capital stock, an additional year of life would be associated with an additional loss in the level of skill. Holding constant the total amount of young people (ie, between 0 and 65) and the total amount of old people (65 and over), an increase in life expectancy would be equivalent to an increase in the depreciation rate of the average elderly relative to the average young. In our simple framework with two generations only, this could be modeled as a discrete increase in the depreciation rate δ.

In Figure 6 I plot the time paths of two economies. I chose parameters in such a way that, in the absence of shocks to life expectancy, the economy where all work (path $\ln(Y_1^{all})$) would always produce more than the economy with social security (path $\ln(Y^{ss})$). Hence, in the absence of changes in life expectancy, social security would NOT be introduced in this economy. After an increase in life expectancy, the economy where all work follows the path labeled $\ln(Y_2^{all})$. Note that now there is a point after which $\ln(Y_2^{all})$ becomes smaller than $\ln(Y^{ss})$. Hence, **the model is consistent with the creation of social security programs after an increase in life expectancy.**

(5b) Increase in the Dependency Ratio.

I want to examine now the effects of an increase in the number of elderly relative to the number of young , holding constant both life expectancy and growth in the to overall population. In Figure 7, I display the time paths for the difference between $\ln(Y^{ss})$ and $\ln(Y^{all})$. Path A refers to a situation where the population structure is constant throughout. Note that the path crosses zero at time $\hat{t}$, which indicates that after this point, social security is desirable. Suppose that a pension system is created after this point. Path B has been drawn under the assumption that at some time $t' > \hat{t}$, there is a once–and–for–all increase in the number of elderly (and a corresponding decrease in the number of young so as to leave total population constant). After this moment we observe that path B shoots way up and crosses

zero at time $\hat{t}$". In other words, if after social security is created, the dependency ratio suffers a sufficiently large once–and–for–all increase, the pension system is no longer desirable.

Hence, **social security economies that suffer increases in the dependency ratio may find it optimal to eliminate the social security program.** The reason is that when most of the population is old, the negative externality is small since the average stock of human capital in the economy and the human capital stock of the elderly are very close.

Consider now the behavior of an economy where the number of elderly grows over time (but the overall size of the population remains constant, so the young population suffers a continuous, negative growth rate). As it was case with a once and for all increase in the dependency ratio, the continuous aging of the population leads the economy to get rid of social security after a while. The reason is, again, that, as the number of elderly becomes so large relative to the vanishing young population, the average human capital of the economy where all work is very close to the level of skill of the old (almost everybody is old). Hence, additional elderly do not contribute negatively to the overall productivity. It pays to get rid of the mandatory retirement laws and social security system.

People often say that the PAYG social security system existing in most countries will collapse if the demographic trends continue to increase the dependency ratio. My analysis suggests that this may be the optimal thing to happen.

(6) Conclusions and Extensions.

In this paper I argued that pensions are just a way to buy the elderly out of their jobs, a way to induce retirement. The reason why societies choose to do such a thing is that aggregate output is higher if the elderly do not work. I modeled this

idea through externalities in the average stock of human capital: because the stock of human capital depreciates with age, one implication of these externalities is that the elderly have a negative effect on the productivity of the young. When the difference between the skill level of the young and old is large enough, aggregate output in an economy where the elderly do not work is higher. Social Security systems will tend to arise.

The story explains why, in the real world, intergenerational transfers are so intrinsically linked to retirement. It also cautions us that we should not study the desirability of such transfers without, at the same time, study the desirability of retirement: before deciding whether pensions are a bad thing to have, one needs to imagine how would the world look like if, all of a sudden, most people between 65 and 95 started working...or did not abandon their tenured jobs!.

The model explains why transfers may exist in a world where altruistic parents are linked to their children though bequests. In other words, it explains why public intergenerational transfers exist in an otherwise Ricardian (or Barrovian) world. Note, however, that the main lessons of the paper do not depend on Ricardian Equivalence holding. The model could just as well be cast in an overlapping generations (OLG) world where people are linked only at conception. One puzzling feature of some OLG approaches to social security is that it is assumed that the government is paternalistic or altruistic towards old people (who were unable or unwilling to save when young), while private individuals are not (people don't like their parents but they like the rest of the elderly, and that is why they prefer to create public schemes to take care of old-age individuals). The story of this paper could explain why people are altruistic towards complete strangers: it is profitable to be nice! A simpler version of the model where there are no inter-firm externalities but where the depreciation rates are very large (people's skills become obsolete as they are superseded by new technologies which they are unable to learn). In this

case the social marginal product of the elderly would not be zero but would be small enough that any small political gain from looking humanitarian would lead to the introduction of pension systems.

The model is consistent with the 'luxury good' property of the pension systems around the world: we observed that social security systems seem to be created only after a certain level of development (and income) has been reached. The explanation for this phenomenon is that, at lower levels of development the rate of technological innovation is low and, therefore, the rate at which human capital depreciates is low. The difference between the skill level of young and old is not large enough so as to warrant retirement schemes. As the economy develops, the rate at which new technologies are introduced increases and, with it, so does the rate of human capital depreciation: like old–vintage machines, people who were trained to work with old technologies become obsolete. The gap between the skill level of the young and the old increases. There is a point at which this gap is large enough that it pays to introduce a pension/retirement system of the type we observe in the real world.

The model also explains why social security enjoys widespread support (income is higher for all players), why social security systems are created irrespective of the political system (as long as the leaders or other voters like more aggregate income, buying the elderly out of their jobs will be desirable), why people have to work for a number of years before being able to collect pensions (people who don't have jobs don't have to be bought out of the labor force) and why pensions are linked to previous wages (the higher your wage, the more you will require to abandon your job).

Even though I don't need to rely on exogenous changes in the population structure to explain the creation of social security programs, the model is consistent with the creation of such programs when life expectancy increases. The reason is that if people die off before old age, there is no need to buy them out. Pension

systems are necessary only when there are elderly around.

Finally, the model predicts that when the dependency ratio increases, the desirability of the social security program decreases. Hence, given the recent population trends in the United States, the movement towards progressive elimination of social security (like the recent amendments to the Age Discrimination in Employment Act) do not seem entirely unreasonable.

Throughout the paper I highlighted a number of shortcomings and interesting extensions to the model. The model was fairly aggregative in at least two ways. On the one hand, it had only one sector. In all probability, jobs in different sectors require different skill levels and the rates at which these levels depreciate over time are also different across sectors. Likewise, human capital externalities are probably more important in some sectors than in others. One could extend the model to a multisectoral world along these lines. The main conclusions will probably not change: retirement in a particular sector will depend on how fast the skill depreciates with age and how important the externality is in that particular sector. It is interesting to note that **one of the first firms to introduce retirement–inducing pensions in the United States was the explosives division of the DuPond Corporation in Wilmington, DE. Railroads, on the other hand, were the first sector to introduce similar schemes** (Graebner (1980)). These are two examples of industries where externalities seem important and where, due to the continuous tension and stress at work, skill depreciation is probably high.

A second source of aggregation was that there were only two types of people: young and old. This did not allow me to talk about the optimal age of retirement and how this age would change in response to the changes in demographic conditions analyzed in section 5. Of course the conclusion that it is optimal to destroy the Social Security Program in response to the continuous aging of the population relies on the age simplification imposed at the outset. In a model with a richer population

structure, the optimal response will probably be an increase in the retirement age.

At the other end, a richer population structure will also allow the study of how these retirement schemes affect the incentives to accumulate human capital when young and, therefore, how they affect long run growth.

Finally, let me mention that changes in the pension system as well as in the retirement laws will have the same aggregate effects as productivity shocks in real business cycles models: the removal of a large number of unproductive elderly from the labor force (and the consequent increase in the productivity of the young) represents a shift in the aggregate production function, just like an improvement in technology. With this in mind, one could conjecture that what ended the Great Depression was not an expansion of monetary aggregates or a New-Deal driven boost in real aggregate demand. It was the 'productivity' shock (actual or anticipated) that the introduction of the 1935 Social Security Act represented.

References

ABC Television, (1992) "Dinosaurs", fridays, 8:30 EST.

Ahmad, S. E., (1991), "Social Security and the Poor", Research Observer, World Bank, Washington DC.

Ahmad, S. E., J. P. Dreze, J. Hills, and A. K. Sen, (1991), 'Social Security in Developing Countries', Oxford University Press.

Alesina, A. and D. Rodrik, (1991), "Distributive Politics and Economic Growth", NBER WP # 3668.

Armstrong, B. Memoirs, Columbia University Documents Library.

Barro, R. J., (1974), "Are Government Bonds Net Wealth?", Journal of Political Economy, vol 86, p. 1095–1117.

Barro, R. J., (1978), "The Impact of Social Security on Private Saving" American Enterprise Institute, Washington DC.

Barro, R. J., (1990), "Government Spending in a Simple Model of Endogenous Growth", Journal of Political Economy, vol 98, October, S103–S125.

Barro, R. J., (1991), "Economic Growth in a Cross Section of Countries", Quarterly Journal of Economics, May, p. 407–443.

Barro, R. J. and H. Wolf, (1990), "Data Appendix to Barro (1990)", mimeo Harvard University.

Becker, G. S., (1964), 'Human Capital', Columbia University Press for NBER.

Boskin, M. J., Editor, (1978a), 'Federal Tax Reform: Myths and Realities', Institute for Contemporary Studies, San Francisco, CA.

Boskin, M. J., Editor, (1978b), 'The Crisis in Social Security : Problems and Prospects', Institute for Contemporary Studies, San Francisco, CA.

Boskin, M. J., Editor, (1986), 'Too Many Promises : The Uncertain Future of Social Security', Dow–Jones–Irwin, Homewood, IL.

Boskin, M. J. and John B. Shoven, (1987), "Concepts and Measures of Earnings Replacement during Retirement', in Bodie, Shoven and Wise editors, *Issues in Pension Economics*', University of Chicago Press for the National Bureau of Economic Research.

Browning, E. K., (1979), "The Politics of Social Security Reform", in Campbell Ed.

Buiter, W. H. and K. M. Kletzer, (1991), "Persistent Differences in National Productivity Levels and Growth Rates with a Common Technology aand Free Capital Mobility", mimeo Yale University.

Burgess, R. and N. Stern, (1991), "Social Insurance in Developing Countries: what, who and how?" in Ahmad et al Ed.

Campbell, C. D., Editor, (1977), 'Income Redistribution' American Enterprise Institute for Policy Research', Washington, DC.

Campbell, C. D., Editor, (1979), 'Financing Social Security' American Enterprise Institute for Policy Research', Washington, DC.

Castellino, O. (1982), "Social Security in Italy" in Rosa Editor.

Diamond, P. A., (1977), "A Framework for Social Security Analysis', Journal of Public Economics p. 275.

Feldstein, M. S., (1977a), "Social Security", in Boskin Ed.

Feldstein, M. S., (1977b), "Social Insurance", in Campbell Ed.

Feldstein, M. S., (1978), "The Impact of Social Security on Private Savings: Reply to Robert Barro, in Robert Barro (1978).

Feldstein, M. S., (1987), "Should Social Security be Means Tested?", Journal of Political Economy, 95 June, p. 568–484.

Glaeser, E., (1992),"Who knows what about whom", mimeo University of Chicago.

Graebner, W., (1980), 'A History of Retirement', Yale University Press, New Haven, CT.

Grossman, G. and E. Helpman, (1991), 'Innovation and Growth in the Global Economy', M.I.T. Press, Cambridge MA.

Habes, W. and W. Cohen, Editors, (1960), 'Social Security: Programs, Problems, and Policies', Irwin, Homewood, IL.

Hemming, R. and J. Kay, (1982) "Social Security in Great Britain" in Rosa Ed.

Hockman, J. (1950), "The Retirement Myth", in Haber and Cohen Eds.

Jacobs, J., (1969), 'The Economy of Cities', Random House, New York, NY.

Jaffee, A. (1986), "Technological Opportunity and Spillovers of R&D: Evidence from Firms' Patents, Profits and Market Value". *American Economic Review.*

Janssen, M. and H. Muller, (1982), "Social Security in Switzerland" in Rosa Ed.

Kotlikoff, L. J., (1987), "Justifying Public Provision of Social Security", Journal of Policy Analysis and Management, p. 647–689.

Kotlikoff, L. J. and J. Gokhale, (1992), "Estimating a Firm's Age–Productivity Profile using the Present Value of Worker's Earnings" forthcoming in Quarterly Journal of Economics.

Kotlikoff, L. J. and D. A. Wise, (1987), "The Incentive Effects of Private Pension Plans", in Bodie, Shoven and Wise editors, *'Issues in Pension Economics'*, University of Chicago Press for the National Bureau of Economic Research.

Lazear, E., (1979), "Why is there mandatory retirement?" Journal of Political Economy, December, p. 275–296

Lazear, E., (1983), "Pensions as Severance Pay" in Bodie and Shoven Eds. *'Financial Aspects of the United States Pension System'*, University of Chicago for the National Bureau of Economic Research.

Lucas, R. E. jr, (1988), "On the Mechanics of Economic Development", Journal of Monetary Economics, 22, p.3–42.

Mackenzie, G. A., (1991), "Selected Issues in Social Security in Latin America", mimeo Fiscal Affairs Department, International Monetary Fund, April.

Merton, R. C., (1983), "On the Role of Social Security as a Means for Efficient Risk Sharing in an Economy Where Human Capital is Not Tradable" in Bodie and Shoven Eds. *'Financial Aspects of the United States Pension System'*, University of Chicago for the National Bureau of Economic Research.

Mesa–Lago, C. (1978), 'Social Security in Latin America', University of Pittsburgh Press, Pittsburgh, PA.

Mincer, J., (1974), 'Schooling, Experience, and Earnings', New York, NBER 1974.

Osler, W., (1910), "The Fixed Period", in Aequanimitas, Philadelphia.

Persson, T. and G. Tabellini, (1991), "Is inequality harmful for growth?", U.C. Berkeley WP.

Romer, P. M., (1990), "Endogenous Technical Change", Journal of Political Economy, 98. p.1002–1037.

Rosa, J. J., Editor, (1982), 'The World Crisis in Social Security', Institute for Contemporary Studies, San Francisco, CA.

Rosen, S. (1976), "A Theory of Life Earnings", Journal of Political Economy, 84 p.545–567.

Schiltz, M. E., (1970), 'Public Attitudes Towards Social Security'

Stahl, I., (1982), "Social Security in Sweden", in Rosa Ed.

Takayama, N., (1982), "Social Security in Japan", in Rosa Ed.

Summers, R. and A. Heston, (1988), "A New Set of International Comparisons of Real Product and Price Levels", Review of Income and Wealth, XXXIV.

U.S. Department of Health and Human Services, (1989), "Social Security Programs throughout the World".

Uzawa, H., (1965), "Optimum Technical Change in an Aggregative Model of Economic Growth" International Economic Review 6, p.18–31.

Vergara, R., (1990), "Government Inability to Commit as a Rationale for Social Security", mimeo Harvard University, February.

White, W., (1937), "Re–echoes of Sir William Osler's 'The fixed period'", Bulletin of the Institute of the History of Medicine, December 1937.

Table 1: Social Security Programs Throughout the World
I: Wage financed? --
H: Are Pensions Related to previous Work? How many years?--
G: Are Pensions related to past earnings?---
F: Retirement age---
E: Economic incentives for retirement?---
D: Is retirement necessary ?---

	country	Law 1st	Current	Coverage	D	E	F	G	H	I
1	AFGANISTAN			P						
2	ALGERIA	49	83	E, S	Y		60	Y	C	Y
3	ANTIGUA	72	72	E	Y		60	Y	C	Y
4	ARGENTINA	44 46	67	E, S	N	Y	60(M) 55(F)	Y	30	Y
5	AUSTRALIA	08	47	residents of limited income	N	Y	65(M) 60(F)	Y	N	N
6	AUSTRIA	06 38	55 57	E (>min.w), S	N	Y	65(M) 60(F)	Y	C	Y
7	BAHAMAS	56	84	E, S	Y	Y	65	Y	C	Y
8	BAHRAIN	76	76	E (firm size>=10), S (excl.) agr., temp.	Y	Y	60(M) 55(F)	Y	15(M) 10(F)	Y
9	BARBADOS	37	66	E, S			65	Y	C	Y
10	BELGIUM	24	69	E, apprentices (sp.) P	Y	Y	65(M) 60(F)	Y	Y	Y
11	BELIZE	79	79	E, S	Y		60	Y	C	Y
12	BENIN	70	70	E	Y	Y	55	Y	I	Y
13	BERMUDA	67	70	E, S	N		65	N	C	Y
14	BOLIVIA	49	56 77	E: industry, commerce,mining,gov.			55(M) 50(F)	Y	C	Y
15	BOTSWANA			P						
16	BRAZIL	23 34	60 88	E: industry & commerce S, (sp.) P			65(M) 60(F)	Y	C	Y
17	BULGARIA	24	57	E, S, collective farmers, handicraft		D	60(M) 55(F)	Y	25(M) 20(F)	N
18	BURK. FASO	60	72	E. (exc.) temp,(sp.) P	Y		55	Y	I	Y
19	BURMA			P						
20	BURUNDI	56	81	E, (sp.) P	N		55	Y	I	Y
21	CAMEROON	69	84	E, (sp.) P	Y		60		C,I	Y
22	CANADA	27 37	65 66	(1) all (2) E, S	N Y	Y Y	65 65	Y Y	Y Y	N Y
23	CAPE VERDE	57	83	E, (sp.) P			65	Y	10	Y
24	C. AFRICA	63	81	E	Y	Y	55	Y	C	Y
25	CHAD	77	77	E	Y	Y	55	Y	Y	
26	CHILE	24	52	E. (vol.) S	Y		65(M) 60(F)	C	C,I	Y
27	CHINA,P.R.	51	86	E	Y	Y	60(M) 55(F)	Y	20(M) 15(F)	N*
28	COLOMBIA	46	46	E: industry & commerce S, (sp.)P, (excl.)agr.	N	Y	60(M) 55(F)	Y	C	Y
29	CONGO	62	71	E, (sp.) P	Y		55	Y	I	Y
30	COSTA RICA	41	71	E, (vol.) S	Y	D	57-65	Y	C	Y
31	CUBA	21 56	79	E, S, members of some producers' cooperatives	Y	Y	60(M) 55(F)	Y	25	N
32	CYPRUS	56	80	E, S	N	N	65	Y	C	Y
33	CZHECHO-SLOVAKIA	06 24	75	E (sp.) farmers	Y	Y	60(M) 55(F)	Y	25	N
34	DENMARK	91 21	64 86	(1) all (2) E, apprentices,	N N	N Y	67	N D	N C	Y
35	DOMINICA	70	75	E, apprentices			60	Y	C	
36	DOMINICAN REPUBLIC	47	48	E, P, etc. (exc.) S, white Collar	Y	Y	60	Y	C	Y
37	ECUADOR	35	88	E: ind, comm, & agr.	Y	Y	55	Y	C	Y
38	EGYPT	50	84	E, (sp.) S, etc.	Y	Y	60	Y	C	Y
39	EL SALVADOR	53	53	E: industry & commerce S	Y	Y	60(M) 55(F)	Y	C	Y
40	ETHIOPIA			P						
41	FIJI	66	74	E, (excl.) P	Y	Y	55	C	C	Y
42	FINLAND	37	56 86	(1) all (2) E	N Y	N Y	65 65	N Y	C C	Y N
43	FRANCE	42	80	E, (sp.) agr., miners, railroads, P.	N		60	Y		Y
44	GABON	63	75	E, (sp.) P	Y	Y	55	Y	C,I	
45	GAMBIA	81	81	E, (sp.) P			55	C		
46	E.GERMANY	89	79 84	E. (sp.) S, miners Railroad, cooperatives	N		65(M) 60(F)	Y	I	Y
47	W.GERMANY	89	11	E (> min w., > min.	Y	D	63	Y	I	Y

Table 1: Social Security Programs Throughout the World

I: Wage financed? ---
H: Are Pensions Related to previous Work? How many years?---
G: Are Pensions related to past earnings?--
F: Retirement age---
E: Economic incentives for retirement?--
D: Is retirement necessary ?---

country	Law 1st	Current	Coverage	D	E	F	G	H	I
		57	hours), (sp.) S, P,						
		73	farmers, miners,						
48 GHANA	65	72	E (firm size >= 5)	N		55(M)	C		Y
			(vol.) small firms & S			50(F)			
49 GREECE	34	51	E: industry & commerce	Y	Y	65(M)	Y	C	
		81	(sp.) P & agr.			60(F)			
50 GRENADA	69	83	E			60	Y	C	Y
51 GUATEMALA	69	69	E. large firms (Sp) P	Y		60	Y	C	Y
52 GUINEA	58	85	E	Y	D	55	Y	C	N
53 GUYANA	44	81	E, S (> min. w)	N		60	Y	C	Y
54 HAITI	65	67	E: (sp.) P			55	Y	C	Y
55 HONDURAS	59	59	E, S, (sp.) P	Y		65(M)	Y	C	Y
			(excl.) casual workers			60(F)			
56 HONG KONG	71	80	residents			65-70	N		N
57 HUNGARY	28	75	E, Cooperatives	Y	D	60	Y	10	Y
58 ICELAND	09	71	(1) all	N	D	67	N	N	N
			(2) E	N	Y	67	Y	Y	N
59 INDIA	52	52	E of firms established	Y		55	N	N	Y
	71	71	at least 3 years						
	72	72	(sp.) P,miners,RailR						
60 INDONESIA	51	77	E of large firms			55	C		N
61 IRAN	53	75	E in specific occupa-	Y		60(M)	Y	Y	Y
			tions and geographical			55(F)		C	
			areas, (sp.) P						
62 IRAQ	56	71	E (firm size >= 5)	Y		60(M)	Y	C	Y
			(exc.) agr. (Sp.) P			55(F)			
63 IRELAND	08	81	E	*		66	N	C	Y
64 ISRAEL	53	82	all, (Sp.) P		Y	65(M)	N*	I	Y
						60(F)			
65 ITALY	19	52	E, (sp.) P, S, farmers	*		60(M)	Y	C	Y
		84	, railroad, merchants.			55(F)			
66 IVORY	60	68	E, (sp.) P	Y		55	Y	10	Y
COAST		88	(excl.) S					C	
67 JAMAICA	58	65	E, S	Y		65(M)	Y	C	Y
						60(F)			
68 JAPAN	41	85	(1) E: industry &	N	Y	60(M)	Y	cov.	Y
			commerce(firm size>=5)			56(F)			
			(2) others	N	Y	65	N	C	Y
69 JORDAN	78	78	E, (excl.) S, agr.			60	Y	C	Y
70 KENYA	65	65	E (sp.) P (exc) casual	Y		55	C		Y
71 KIRIBATI	76	76	E		Y	50	C		Y
72 S. KOREA	73	86	resident(firmsize>=10)			60	Y	I	Y
73 KUWAIT	76	76	E	Y		50	Y	C	Y
74 LEBANON	63	63	E: industry, commerce	Y		60(M)	Y	20	N
			& agr., (sp.) P,			55(F)		etc.	
75 LIBERIA	72	80	E (firm size >= 25)	Y		60	Y	C	Y
			(excl.) casual workers						
76 LIBYA	57	80	E	Y		65	Y	C	Y
77 LUXEMBOURG	11	25	E, (SP.) P, rairoads,	Y		65(M)	Y	C	
	31	64	(vol.) S Ind. & Trade			60(F)			
78 MADAGASCAR	69	69	E, (excl.) temp. and	Y		60(M)	Y	C,i	Y
			casual workers, (sp.)P			55(F)			
79 MALAWI			(sp.) P						
80 MALAYSIA	51	51	E (< max. w),	Y		55	C		Y
	69	69	(exc.) agr. & casual						
81 MALI	61	66	E, (sp.) P, (vol.) S	Y		55	Y	30	Y
82 MALTA	56	56	residents		Y	61(M)	C	C,I	Y
			(excl.) nonemployed			60(F)			
			married women						
83 MARSHALL I	67	83	E			60	Y	cov.	Y
84 MAURITANIA	65	67	E, (sp.) P	Y		60	Y	C,I	
85 MAURITUS	51	76	(1) all residents			60	N		N
			(2) E, (vol.) S			60	Y		Y
86 MEXICO	43	73	E, Cooperatives	*		65	Y	C	Y
87 MICRONESIA	67	83	E			60	Y	cov.	Y
88 MOROCCO	59	81	E: Ind., Commerce, Agr	Y		60	Y	I	Y
			(sp.) P						

Table 1: Social Security Programs Throughout the World

I: Wage financed? ---

H: Are Pensions Related to previous Work? How many years?---

G: Are Pensions related to past earnings?---

F: Retirement age--

E: Economic incentives for retirement?--

D: Is retirement necessary ?---

| | Law | | | | | | | | |
country	1st	Current	Coverage	D	E	F	G	H	I
89 NEPAL	62	62	gov., corporate	Y			C		Y
90 NETHER-LANDS	13	75	all residents	N		65	N	C	Y
91 NEW ZEALAND	98	76	all residents (sp.) P	N	Y	60	N	N	N
92 NICARAGUA	55	82	E, (excl.) temp. etc.	Y		60	C	Y	Y
93 NIGER	67	67	E, (sp.) P	Y		60	Y	C,I	Y
94 NIGERIA	61	61	E (firm >= 10), (sp) P (excl.) S, Casual	Y		55	C		Y
95 NORWAY	36	66	(1) all residents			67	N	cov.	Y
			(2) E & S (> min. w)			67	Y		Y
96 PAKISTAN	72	76	E large firms (sp.) P, railroads	Y		60(M) 55(F)		C	N
97 PALAU	67	87	E			60	Y	cov.	Y
98 PANAMA	41	54	E, etc. (sp.) P (excl.) agr., casual		Y	60(M) 55(F)	Y	C	Y
99 PAPUA NG	80	80	E (firm size >= 25)	Y			C		Y
100 PARAGUAY	43	73	E, (sp.) P, rail-roads	N	Y	60	Y	C	Y
101 PERU	36	73	E, (vol.) S	Y		60(M) 55(F)	Y	cov.	Y
102 PHILIPPINE	54	54	E,(sp.) gov.,(Exc.) S	Y		60	Y	C	Y
103 POLAND	27 33	82	E, Farmers, Cooperatives (sp.) miners,railroads	Y		65(M) 60(F)	Y	20(M) 15(F)	N
104 PORTUGAL	35	77 88	E, (sp.) S in industry , gov., etc.	Y		65(M) 62(F)	Y	C,I	Y
105 ROMANIA	12	77	E, (sp.) agr. coop.			60(M) 55(F)	Y	30(M) 25(F)	Y
106 RWANDA	56	74	E	Y		55	Y	C,I	Y
107 S. CRISTOPH. & NEVIS	70	77	E, (vol.) others			62	Y	C	Y
108 S. LUCIA	70	78	E, apprentices	Y		60	Y		Y
109 S. VINCENT	70	86	E			60	Y	C	Y
110 SAO TOME & PRINCIPE	79	79	E, (sp.) S	N		65(M) 60(F)	Y	C	Y
111 SAUDI ARABIA	62	69	E. Large Firms, (Sp) P. (Exc.) Agr, Casual W.	Y		60	Y	C	Y
112 SENEGAL	75	75	E, (sp.) P	Y		55	Y		Y
113 SEYCHELLES	71	79	E (sp.) P		Y	65	N		Y
114 SIERRA L.			(sp.) P						
115 SINGAPORE	53	85	E (>min. w)			55	C		
116 SOLOMON I	73	73	E (>min. w)	Y*			C		
117 SOMALIA			(sp.) P						
118 SOUTH AFRICA	28	67 68	residents of limited means, (sp.) P			65(M) 60(F)	N		N
119 SPAIN	19	74	E: industry & services (sp.) S, P, agr.	Y		65	Y	C	Y
120 SRI LANKA	58	58	E, (sp.) P	Y		55(M) 50(F)	C	N	Y
121 SUDAN	74	74	E (firm size >= 30) (sp.)P, (excl.)S,etc.	N		60(M) 55(F)	Y	C	Y
122 SWAZILAND	74	74	E, (sp.) P, (excl.) casual		Y	50	C		Y
123 SWEDEN	13	76	(1) all residents	N	D			N	N
			(2) E, S (>min. w)	N	Y	65		Y	Y
124 SWITZER-LAND	46	46	all residents	N		65(M) 62(F)	Y		Y
125 SYRIA	59	59	E: ind, comm & agr, (sp.) P, (exc.) casual		Y	60	Y	C	Y
126 TAIWAN	50	68	E: Large Ind., Mining, P.(vol.) small firms	Y	D	60(M) 55(F)	Y	cov.	Y
127 TANZANIA	64	64	E (firm size > 4), (sp.) P	Y		55	C		Y
128 THAILAND			(sp.) P						
129 TOGO	68	73	E, cooperatives (sp.) P	Y	Y	55	Y	C,I	Y
130 TRINIDAD & TOBAGO	39	39	E	Y	Y	60		C	Y
	71	71	poor residents	Y	Y	60		C	Y

Table 1: Social Security Programs Throughout the World
I: Wage financed? --
H: Are Pensions Related to previous Work? How many years?--
G: Are Pensions related to past earnings?---
F: Retirement age---
E: Economic incentives for retirement?--
D: Is retirement necessary ?--

country	Law 1st	Current	Coverage	D	E	F	G	H	I
131 TUNISIA	60	74	E	Y		60	Y	C	Y
132 TURKEY	49	64	E: industry & commerce			55	Y	C,I	Y
133 UGANDA	67	72	E (firm size >=5) (sp.) P, (excl.) temp.,		Y	55	C		Y
134 SOVIET UNION	22	56	E, state farmworkers, collective farms		Y	60(M) 55(F)	Y	25(M) 20(F)	N
135 U.K.	08 25	86	all residents,coverage optional for E with < min. w.	N	Y	65(M) 60(F)	Y	Y C	Y
136 U.S.A.	35	35	E. (exc.) casual, agr. limited S, etc.	N	Y		Y	cov.	Y
137 URUGUAY	28	87	E, S	Y		60(M) 55(F)	Y	30 cov.	Y
138 VANUATU	70	86	E			60	Y	C	Y
139 VENEZUELA	66	66	E, (excl.) S, temp., casual workers	N	D	60(M) 55(F)	Y	C	Y
140 W. SAMOA	72	72	E	Y		55	C		Y
141 YEMEN	87	87	E, (excl.) agr., casual workers			60(M) 55(F)		I	Y
142 YUGOSLAVIA	22	72	E: industry, commerce & agr., P, handicraft cooperatives.	Y		60(M) 55(F)	Y	I	Y
143 ZAIRE	56	61	E, (sp.) P	Y		58	Y	I	Y
144 ZAMBIA	65	73	E, (sp.) P. (Exc.) S, Casual, Cooperatives.	Y		50	C		Y

Notes to Table 1

Source: Social Security Programs Throughout the World
    (U.S. Dept of Health and Human Services, 1989)

(1) ABBREVIATIONS:

For 'Coverage' Column:
E: employees or employed persons, S: self-employed persons
P: public, agr.: agricultural workers
gov.: government workers, temp.: temporary workers
(sp.): special systems, (excl.) exclusion, (vol.) volantary

For Column E
D: incentive for deferral of retirement or pension

For Column G
C: related to years of contribution, I: related to years of insur
cov.: related to years of coverage
M: men, F: women (same for H)

For Column H
C: equal to the total amount of contribution

(3) OTHER NOTES ('*' in Table 1)

To Column A:
34: 1891, 46:1889, 47:1889, 91:1898

To Column D
63: necessary if pension is drawn at age 65.
65: may work until 65 if less than 40 years of contribution.
    necessary for length of service pension.
86: not required if you work for a new employer
    and after 6 months of waiting.
116: you get pensions from age 40 if retired
     otherwise from 50.

To Column G:
64: related to national average wage

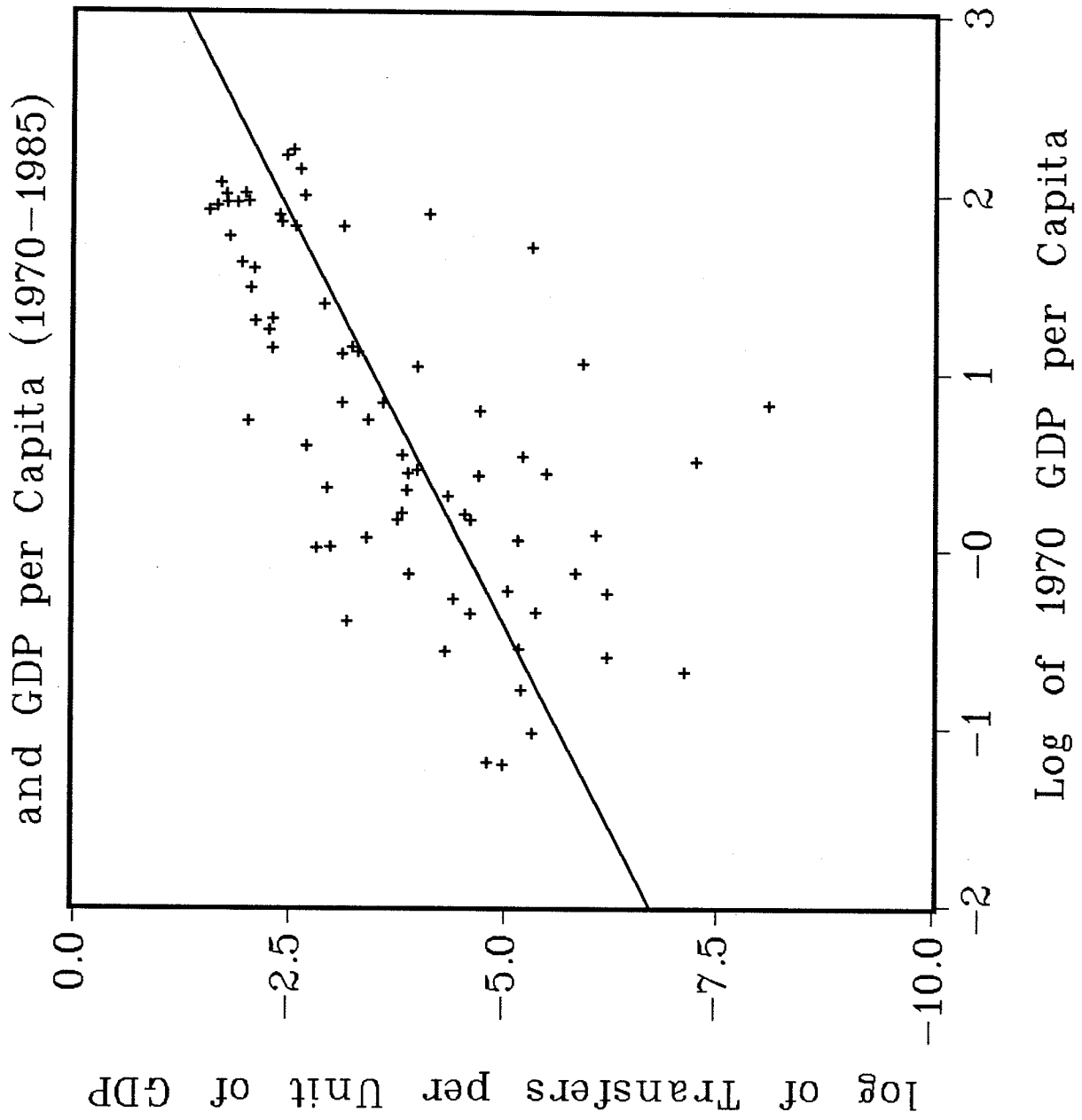Figure 1: Cross Country Association between Transfers and GDP per Capita (1970–1985)

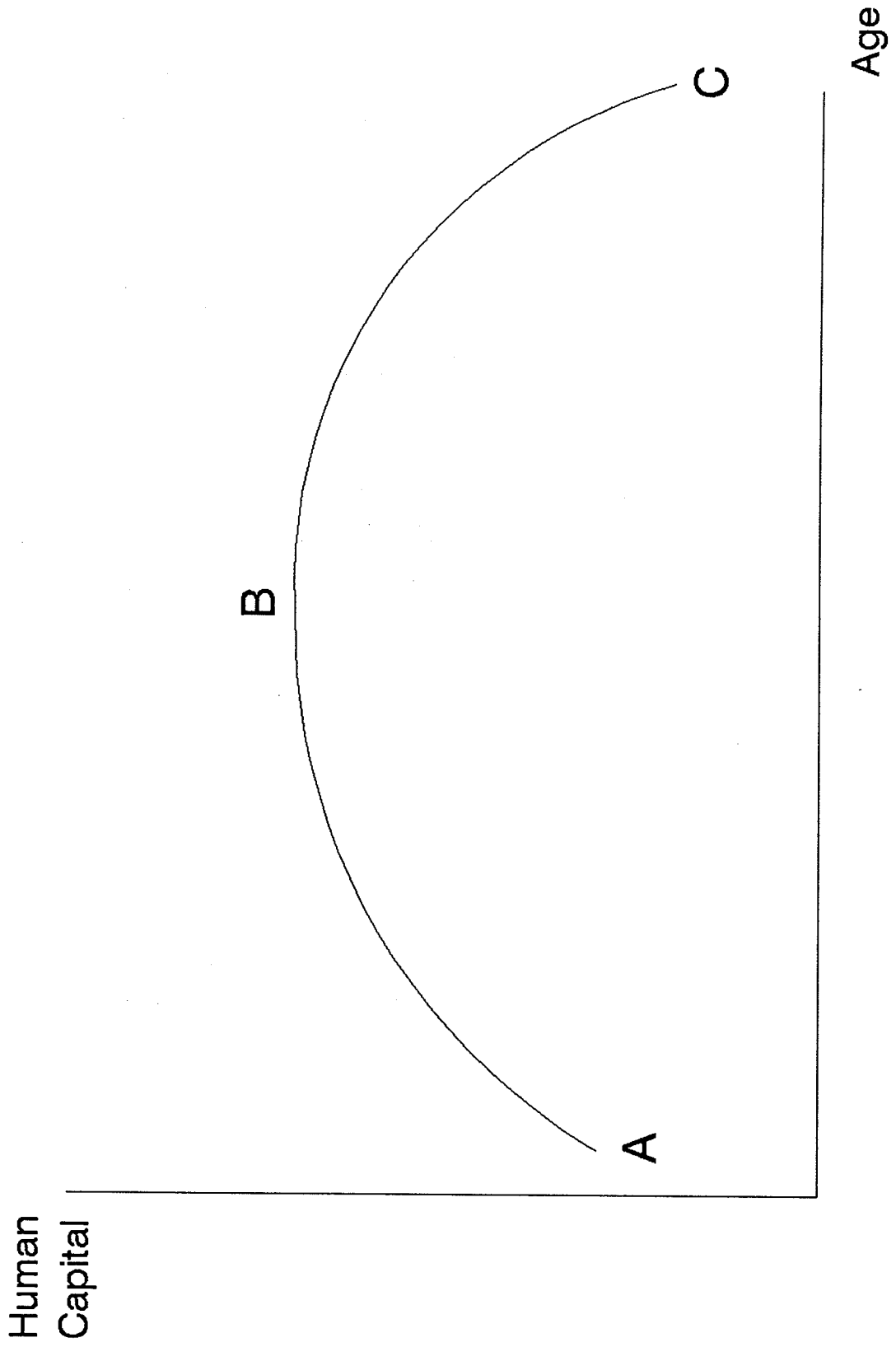Figure 2: Human Capital Over the Life-Cycle

Figure 3: Depreciation Schedule

Figure 4: Time Paths

$\ln(Y^{SS})$

$\ln(Y^{All})$

Time path of Economy
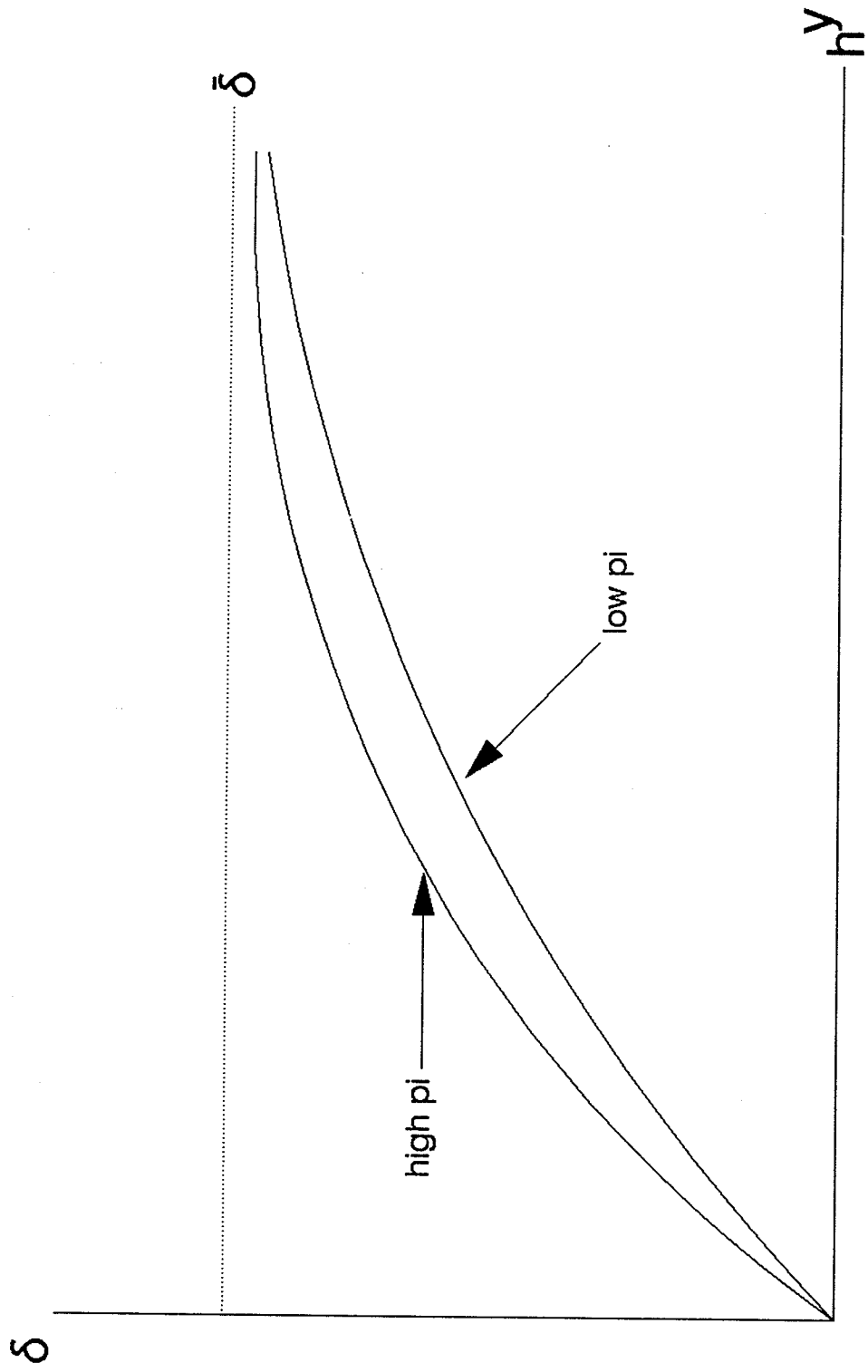Where Elderly Retire

Time path of Economy
Where All Work

$\hat{t}$

Time

$\ln(Y)$
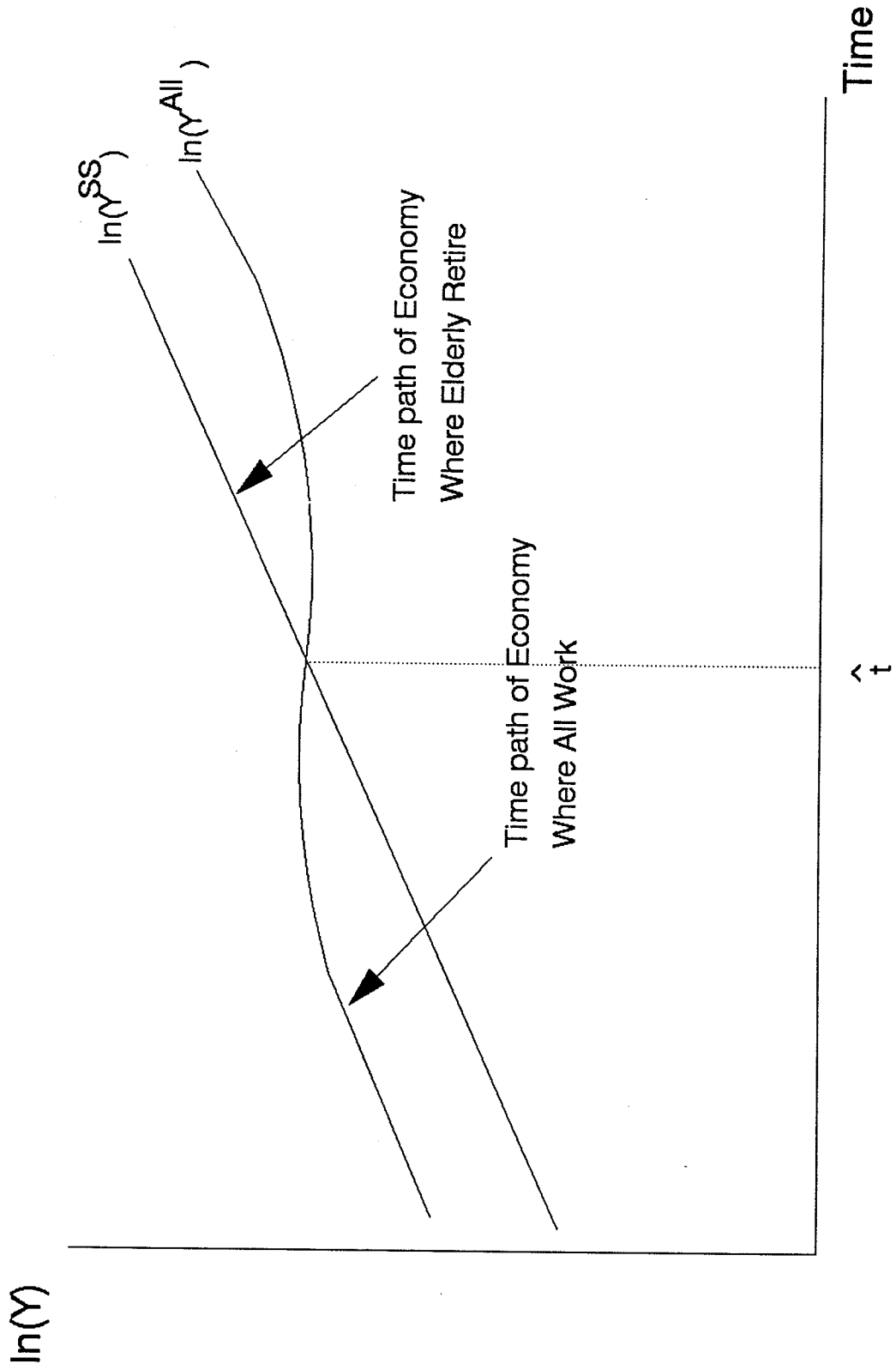
Figure 5: Difference in log income over time
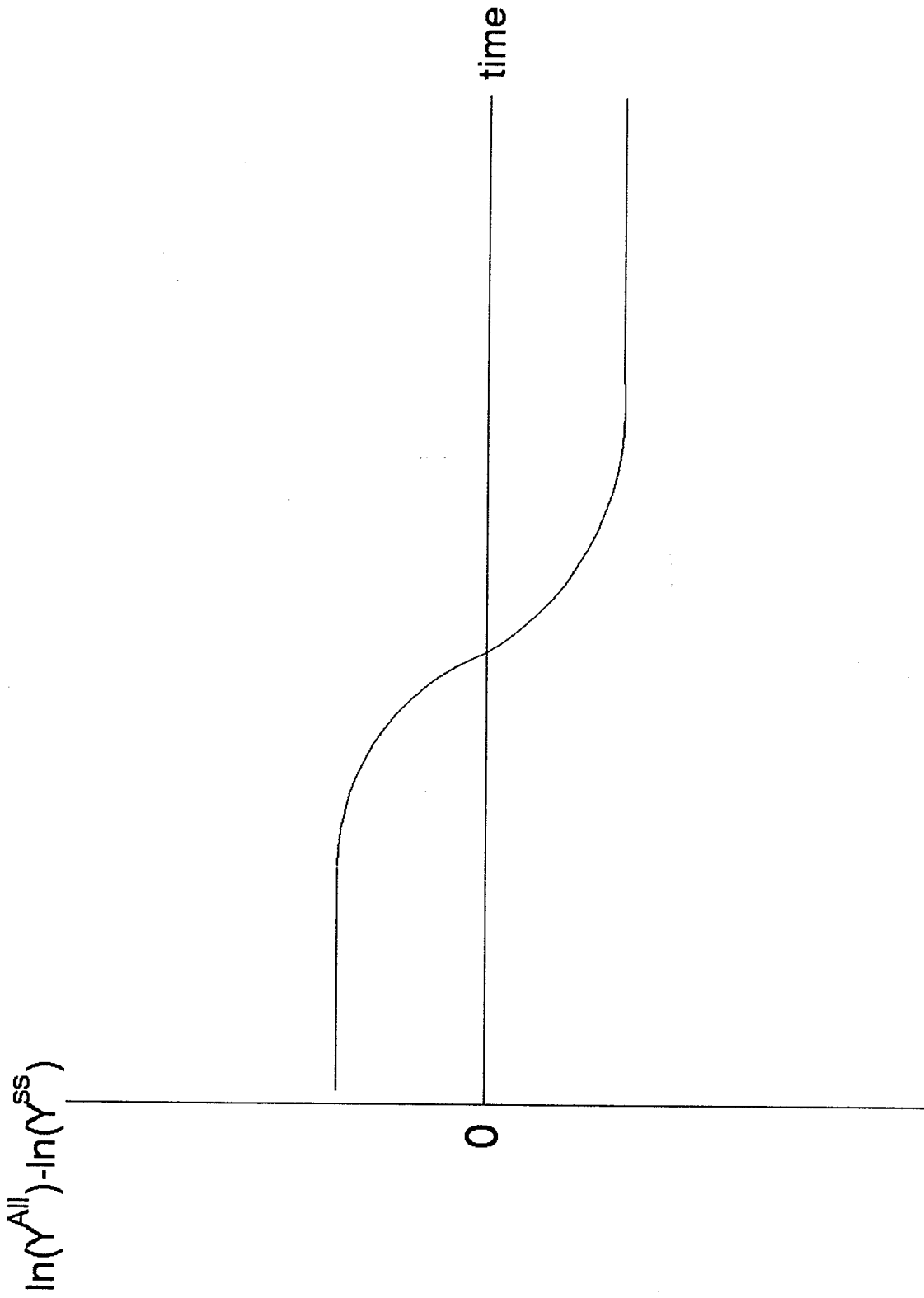
Figure 6: Increase in Life Expectancy

ln(Y)

Time Path of Economy
Where All Work
When NO increase in Life Expectancy

$\ln(Y_1^{All})$

$\ln(Y^{SS})$

$\ln(Y_2^{All})$

Time path of Economy
Where Elderly Retire

Time path of Economy
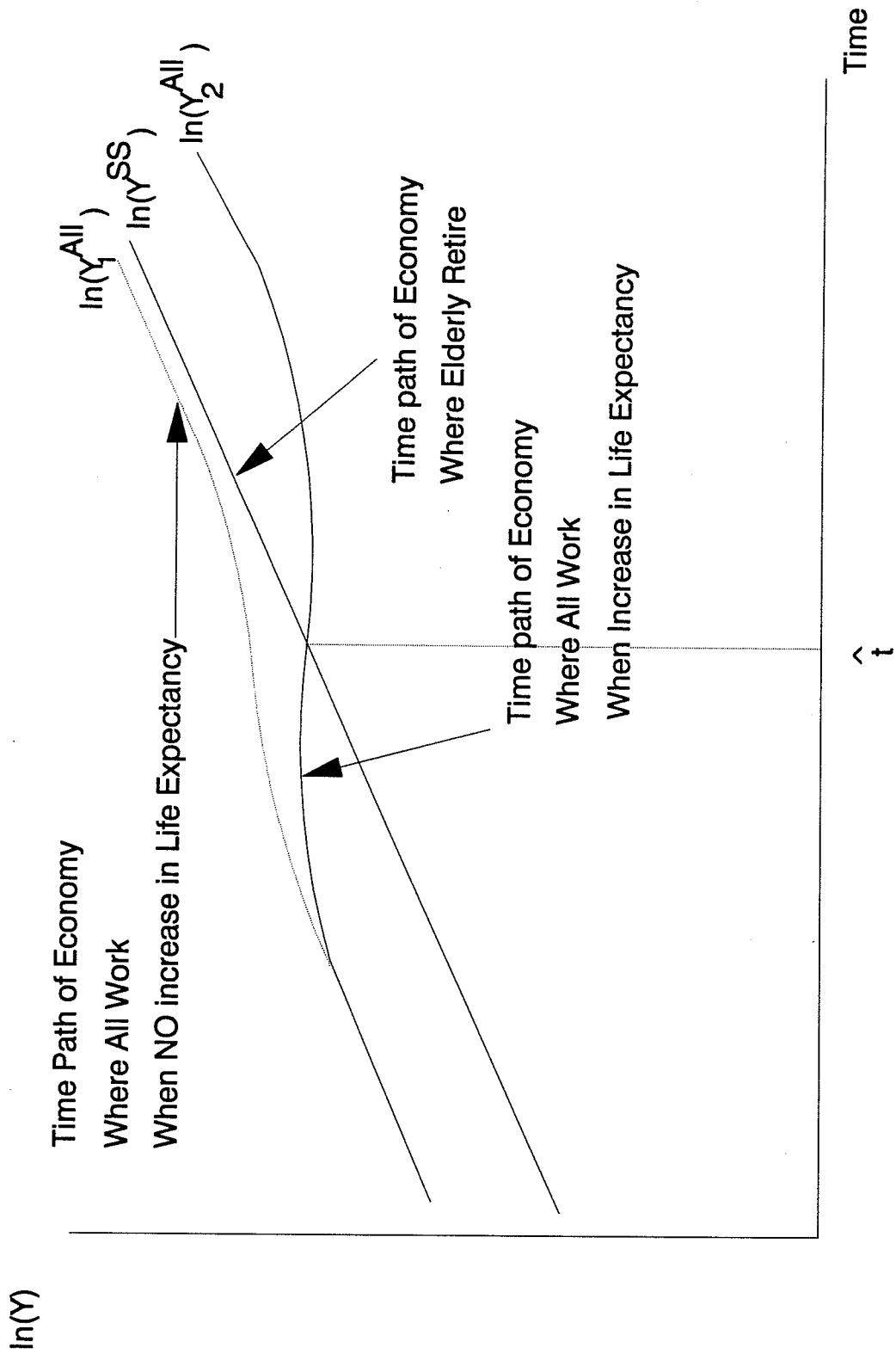Where All Work
When Increase in Life Expectancy

$\hat{t}$

Time

Figure 7: Once-And-For-All Increase in Dependency Ratio