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A Positive Theory of Social Security*

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Abstract

In this paper I make two points. First, I argue that Social Security programs around the world link public pensions to retirement: people do not lose their pensions if they make a million dollars a year in the stock market, but they do confront marginal tax rates of up to 100 percent if they choose to work. Second, after arguing that most existing theories cannot explain this fact, I construct a positive theory which is consistent with it. The main idea is that pensions are a means to induce retirement, that is, to buy the elderly out of the labor force. The reason is that aggregate output is higher if the elderly do not work. This is modeled through **positive** externalities in the **average** stock of human capital: because skills depreciate with age, the elderly have lower than average skill and, as a result, they have a negative effect on the productivity of the young. When the difference between the skill level of the young and that of the old is large enough, aggregate output in an economy where the elderly do not work is higher. Retirement is desirable in this case, and social security transfers are the means by which such retirement is induced. The theory developed in this paper is also shown to be consistent with a number of other regularities documented in section 1.

"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' (White (1937).) 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 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" (White (1937).) For the first time in United States history, people debated whether free individuals should be forced to retire for age reasons.[1] 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 1994 Economic Report of the President).

Despite the large and growing importance of transfers, most of the researchers studying

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[1] Most Americans at the time thought that mandatory retirement was an unacceptable public interference with personal freedom. 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).

the determinants of long run economic growth have ignored the existence of transfers.[2] 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 Persson and Tabellini (1991), and Alesina and Rodrik (1994)). 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

$$\underset{}{Gr7085 = -0.000} \underset{(0.004)}{- 0.015\ Ln(GDP70)} \underset{(0.047)}{- 0.129\ GC} \underset{(0.155)}{- 0.228\ GI} \underset{(0.054)}{+ 0.111\ SS} \underset{(0.041)}{+ 0.217\ I}$$

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). Cashin (1993) gets even stronger results using panel data for twenty OECD countries: transfers seem to be the only component of public spending that is positively

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2 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.

correlated with the growth rate (holding constant the initial level of income.)

The goal of this paper is to present a positive theory of social security. The main idea is that social security programs and intergenerational 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 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.[3]

I model this idea through positive externalities in the average stock of human capital. Like Lucas (1988, 1990), I use a production function where people's productivities depend not only on their own ability, 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.[4] Hence, old workers have lower than average skill and, consequently, exert a negative externality on the rest of the labor

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3 The first pension system on record is the one instituted for the military in ancient Rome. By giving the retired generals a pension and some land way outside the city a double goal was achieved: they were kept away from power and they became a first shield of experience warriors who protected Rome from barbaric invaders.

4 The productivity of people above 65 is probably lower. Since most of them do not work, we do not have real data on this.

force. If the externality is important enough, aggregate output will be larger if the elderly do not work. Social Security 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'.[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 final Act does not talk about efficiency is that

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See for instance Barbara Armstrong's Memoirs, Columbia University (Armstrong was a Berkeley law professor and a member of the committee on Social Security appointed by the President in 1934 to draft the Social Security Act.
Another thing that was in the minds of the founders was that social security would be a way to introduce job sharing (remember that this was being done in the middle of the great depression.) 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)).

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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.

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 'a reward for life-long job well done' 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 with 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, 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 public transfers, 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 (see Tabellini (199)).

All these theories completely assume that the elderly retire 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.[7]

The rest of the paper is organized as follows. In Section 1 some facts about social security programs around the world are presented. In section 2 the model is introduced and some empirical evidence in support of human capital externalities (a key aspect of the model) is cited. Section 3 studies the steady-state behavior of the economy and analyze the conditions under which economies will choose to introduce a social security system. The next section deals with the transition and explains why economies might introduce social security only as they reach a certain level of income. Section 5 allows for changes in the population structure and shows that when life expectancy increases the desirability of social security increases and that when the

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[7] 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.

dependency ratio increases, the desirability of a social security system is reduced. The final section concludes and suggests 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 Bismarck. 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 (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 relevant legislation in each country).

The short history of social security systems 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 protection or imperial palaces[8].

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[8] 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

One way to asses the relation between social security and the level of development is to look at the correlation between income per capita and the size of social security transfers as a share of GDP for a cross-section of countries. The correlation coefficient is .7.[9] 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%.

This positive association is still true after the fraction old people in total population is held constant (the coefficient on initial income is .406, s.e.=.202, which suggests that a 1% increase in income per capita increases transfers by 1.406%.)[10,11]

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that performed with the lions charged very high fees for their appearances. The lions themselves were purposefully 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...)

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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.

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Measurement error in the population ratio could explain why the income level variable is significant. By the same token, however, measurement error in the income variable would tend to give 'too much' importance to the population ratio. It could be persuasively argued that it is easier to count people than to count units of GDP so I would guess that these coefficients tend to underestimate the true partial correlation between transfers and the level of income.

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The reason why the fraction of old people is not enough to account for the positive relation between income and transfers is that in most industrial nations, the system is universal in that all employed persons are covered by the social security program (agricultural workers and self employed seem to be an exception in a lot of countries). In developing countries, on the other hand, 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

(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 (column D in table 1 shows that this is true for 70 out of 108 countries where this information is available.) For most the rest of the countries the social security program provides strong economic incentive to retire (Australia, Canada, Japan, New Zealand, the United Kingdom and the United States are examples of this; see column E in Table 1.) 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)).

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!.

(1978), Ahmad (1991), Mackenzie (1991), and the papers in Ahmad et al (1989) for evidence on this point.

(1c) Pensions are linked to previous wages.

In most social security programs, a worker's earnings determine, in full or in part, his benefits. For 130 out of 139 countries where information is available, the pension a person receives is linked to his previous wage history (see column F in Table 1.) In some countries the benefits are simply 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.

(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) Social Security Programs tend to be 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) The Creation of the Social Security Program Is Not related to a 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.

How do existing theories explain these facts?

Existing theories of public social security can explain some, but not most, of these facts. For instance, the political economy story argues that at some point in time the elderly achieve some kind of majority and vote themselves a big transfer. This can certainly explain why transfers appear only after a certain level of development has been reached (it is true that the fraction of the population aged above 65 increases with the level of development of a country.) The main problem for the political economy theory is that it cannot readily explain why the elderly would vote themselves a big transfer, and then force themselves to retire in order to collect it. It would make much more sense for the elderly to give themselves a choice as to whether to retire or not.[12]

Theories of paternalistic governments run into similar kinds of problems. They cannot explain why the (paternalistic) government forces old people to retire in order to collect the benefits, instead of leaving them the choice as to when to terminate their working lives. Furthermore, it needs to explain why, all of a sudden, the government became paternalistic at the end of the XIX century or why governments in rich countries are more paternalistic than governments in poor countries.

Theories that rely on capital market imperfections cannot explain why rich countries have larger social security programs and, at the same time, less imperfect capital markets. Similarly, since capital markets have been imperfect for a long time, why didn't social security programs exist until the last decade of the XIX Century? Finally, it is not at all clear why imperfect capital

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12 The political story cannot explain why social security schemes are introduced in non-democratic countries either (although some kind of lobbying story could be embodied in a political model of public pensions).

markets should lead to the introduction of public pensions conditional on retirement.[13] The same criticisms also apply to the theory of people free-riding on each other's utility.

(2) The Model.

(2a) Production Functions and Human Capital Externalities.

Firm j employs N_t^j workers during period t. Each worker has a different level of skill or human capital. A worker of skill h^{ij} is assumed to be 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 $H_t^j = \sum n_t^{ij} h_t^{ij}$. The production possibilities of a firm at time t can be described by a neoclassical production function extended by two human capital externality factors:

$$(1) \qquad Y_t^j = A K_t^{j^{\alpha}} H_t^{j^{1-\alpha}} \left(\frac{H_t^j}{N_t^j} \right)^{\epsilon_j} \left(\frac{H_t}{N_t} \right)^{\epsilon}$$

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 (where $N_t^j = \sum_i n_t^{ij}$) . The term $\left(H_t^j / N_t^j\right)^{\epsilon_j}$ is an 'intra-firm

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[13] It should be pointed out that Diamond (1977) argues that retirement incentives would be incorporated in an efficient design of a disability insurance scheme given the inability to fully verify who is and is not disabled. The government wants to insure that only those who really need old age disability insurance receive it, so it prohibits, via the earnings test, disability insurance recipients from working.

externality'[14] from the **average** human capital of the firm's 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. 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. This will be called 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, 1990). 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.[15] 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.

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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. This is not an externality in the widely accepted sense of the word, so we may want to call it **'internality'** instead.
This intra-firm externality is not really central to the paper, but it will be useful to distinguish the necessity of a publicly provided social security program from a private retirement/pension scheme.

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I am not only assuming that human interaction in production generates externalities, but also that these externalities cannot be avoided. People can purposefully avoid having some types of interaction with certain workers that are harmful to their productivity. Hence, we should think of ϵ_j as reflecting those interactions that cannot be avoided.

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.

Jacobs (1969) provides a number of examples highlighting the importance of these social interactions in academics, the arts as well as many other occupations. 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"*.

But externalities from the average quality of the labor force do not necessarily reflect social interaction. Following Arrow (1962), we could imagine jobs where there is learning by doing and where the things learnt in one firm spill over into other firms (see Jaffee (1986) and Jaffee et al. (1992) for evidence on this). Imagine also 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.

Lucas (1988) 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. Using macroeconomic data, Lucas (1988, 1990) estimate ϵ to be about .36. Using a large cross-section of countries, Chua (1993) quantifies the human capital externality to be somewhere between .06 and .15.

Caballero and Lyons (1990) and Bartelsman et al.(1991) provide microeconomic evidence on the importance of these externalities in the manufacturing sector of the United States and Europe. Their estimate of the size of the inter-firm externality (which corresponds to ϵ in equation 1) is about 5% (see also Jaffe (1986),and Jaffe et al. (1992) for more microeconomic evidence.)

The type of externalities described above are probably not economy-wide but, rather,

sector-specific (or maybe externalities across similar sectors or regions (see Jaffe (1986) and Jaffe et al. (1992).) The main message of this paper, however, does not require the externalities to be economy-wide.

(2b) A Two-Generation Economy.

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

$$(2) \qquad Y_t^{all} = AK_t^{\alpha}\left(n_t^y h_t^y + n_t^o h_t^o\right)^{1-\alpha}\left[\frac{\left(n_t^y h_t^y + n_t^o h_t^o\right)}{N_t}\right]^{\epsilon_j}\left[\frac{\left(n_t^y h_t^y + n_t^o h_t^o\right)}{N_t}\right]^{\epsilon}$$

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

$$(3a) \qquad w^{o,all} = \frac{\partial y^{all}}{\partial n^o} = (1-\alpha)\frac{h^o y^{all}}{n^o h^o + n^y h^y} + \epsilon_j y^{all}\frac{n^y[h^o - h^y]}{(n^o + n^y)(n^o h^o + n^y h^y)}$$

$$(3b) \qquad w^{y,all} = \frac{\partial y^{all}}{\partial n^{y}} = (1-\alpha)\frac{h^{y} y^{all}}{n^{o}h^{o} + n^{y}h^{y}} + \epsilon_{j} y^{all} \frac{n^{o}[h^{y}-h^{o}]}{(n^{o}+n^{y})(n^{o}h^{o} + n^{y}h^{y})}$$

$$(3c) \qquad r^{all} = \frac{\partial Y}{\partial K} = \alpha \frac{Y^{all}}{K}$$

where I omitted time subscripts to simplify notation. The firm internalizes the intra-firm externality (or internality) 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 his firm through his contribution to the average human capital (second term in (3a) and (3b)).

An important point is that if the human capital of the old person is lower than that of a young, then the wage rate of the old will be lower in the presence of intra-firm externalities (note that the second term in 3a involves ϵ_j multiplying $[h^o-h^y]$; this term is negative if $\epsilon_j>0$ and $h^o-h^y<0$.) 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 effect 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.

Firms, on the other hand, do not internalize the inter-firm externality represented by $\epsilon>0$:

the effect of a person working for firm j on the workers of all other firms is NOT reflected on his wage. The social marginal products of old and young workers are

$$\frac{\partial y^{all}}{\partial n^{o}_{social}} = (1-\alpha)\frac{h^{o}y^{all}}{n^{o}h^{o}+n^{y}h^{y}} + (\epsilon_{j}+\epsilon)y^{all}\frac{n^{y}[h^{o}-h^{y}]}{(n^{o}+n^{y})(n^{o}h^{o}+n^{y}h^{y})}$$

and

$$\frac{\partial y^{all}}{\partial n^{y}_{social}} = (1-\alpha)\frac{h^{y}y^{all}}{n^{o}h^{o}+n^{y}h^{y}} + (\epsilon_{j}+\epsilon)y^{all}\frac{n^{o}[h^{y}-h^{o}]}{(n^{o}+n^{y})(n^{o}h^{o}+n^{y}h^{y})}$$

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, some societies may not want the elderly to work, despite the fact that profit maximizing firms are willing to pay positive wage rates for their services.

(2c) 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

$$(2)' \qquad Y_t^{SS} = AK_t^{\alpha}\left(n_t^{y} h_t^{y}\right)^{1-\alpha}\left[\frac{n_t^{y} h_t^{y}}{N_t^{y}}\right]^{\epsilon_j}\left[\frac{n_t^{y} h_t^{y}}{N_t^{y}}\right]^{\epsilon}$$

where Y^{ss} stands for output under Social Security. 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

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

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.

(2d) 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 (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. This paper is most interested on the effects of the inevitable decline in human capital that accompanies the passage of time, that is the

downward-sloping section of the skill-age profile. Therefore, and in order to keep the model as simple as possible, the early stages of life when individuals accumulate skills will be neglected. It will simply assumed that a young person born at t+1 inherits the human capital that his parents had when they were young, augmented by some growth factor γ[16]

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

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. Following Romer (1990) and Grossman and Helpman (1991), the rate of technological innovation could be assumed to be an increasing function of the level of human capital ($\gamma(h^y)$ with $\gamma'(h^y)$.) This result reflects the fact that technological innovations are made by researchers whose quality is reflected in h^y.

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 will be apparent later on, the main

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A small amendment along the lines proposed by Lucas (1988) could embody this analysis into a model of endogenous growth. 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. See Mulligan and Sala-I-Martin (1993) for a detailed analysis of such models. The main lessons from the present paper, however, do not depend on whether growth is exogenous or endogenous.

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 this model represents an adult worker at the peak of his career. In order to reflect the loss of human capital due to the passage of time, it is assumed that if an agent's skill level is h_t^y when young, his skill when old will be

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

where $\delta(h_t^y)$ is the rate of human capital depreciation with $\delta'()>0$ and $\lim_{h^y \to \infty} = \bar{\delta} \leq 1$. The assumption of increasing depreciation rates is based on two arguments. First, I want to capture the idea that technology in rich economies changes rapidly and, as result, a person's skills become obsolete relatively quickly. In other words, in the real world most people's skills are linked to the technology available at the time when they are learnt (like physical capital, human capital is vintage -or technology- specific.) Moreover, it is hard for old people to learn new technologies: old secretaries find it difficult to learn modern computer programs, old professors have a hard time learning new theories and tools, old salesmen cannot cope with new sales methods.[17] When technological progress occurs, the skill embodied in existing workers suffers economic depreciation (because their skills are linked to the previous technological environment, technological progress renders them obsolete.) It follows that the larger the rate of technological progress, the larger the rate of technological depreciation (so $\delta = \delta(\gamma)$ with $\delta'()\geq 0$.) If, as in

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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)).

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 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.[18] It follows that the depreciation rate is an increasing function of the level of skill.

Since we are considering only two generations, we should think of $\delta()$ as the depreciation rate over a period of approximately 25 years.[19] 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 over a period of 25 years do not seem unreasonable.

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[18] 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.

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

(2e) Consumers.

Following Barro (1974), it will be assumed that individual agents care about their own lifetime utility and about that of their children.[20] Hence, the utility function of a person born at t is

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

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[21]. 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 and he may receive a pension T_{t+1} instead. He consumes c_{t+1}^o. His budget constraints are therefore:

$$(7) \qquad c_t^y + s_{t+1}^y = w_t^y(1-\tau) + b_t$$

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20 As pointed out by Barro, this intergenerational altruism generates debt neutrality. The main lessons of the paper in no way depend on whether Ricardian Equivalence holds or not. In fact, this Ricardian world is the most hostile environment to explain the existence of social security so if we can explain it in this environment, it would be even easier to do it in a simple OLG model where people are linked only at conception.

21 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.

$$c^o_{t+1} + (1+n)b_{t+1} = w^o_{t+1} + T_{t+1} + s^y_{t+1}(1+r_{t+1})$$

The government budget constraint depends on whether the social security 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: $\tau \cdot w^y_t \cdot (1+n) = T_t$.[22] If we add up the constraint for all the people alive at time t we get

$$C_t + S_{t+1} - S_t = W^y_t + W^o_t + r_t S_t \tag{8}$$

where C_t is total consumption, S_t is the total amount of financial assets in period t, and W^y_t and W^o_t are the total wage bills for young and old respectively (W^o_t 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

$$u'(c^y_{t+1}) = u'(c^o_{t+1})(1+\psi)/(1+\rho) \tag{9}$$

$$u'(c^y_t) = u'(c^o_{t+1})(1+r_t)/(1+\rho)$$

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

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[22] A fully funded social security system would require agents to buy τw^y_t units of asset A_{t+1} when young and would refund $\tau w^y_t(1+r_{t+1})$ when old.

Equivalence result. For simplicity, I have assumed zero population growth, n=0 (in section (5) I analyze changes in the population structure).

(2f) Equilibrium.

In order to get closed form policy functions I consider the case of logarithmic utility and full depreciation of physical capital. Furthermore I assume that $\rho=\psi$, that is, the rate at which we discount our children is the same as the rate at which we discount our own future[23]. The resulting policy function for investment is

$$(10) \qquad K_{t+1} = \alpha \frac{Y_t}{1+\rho}$$

where the first order conditions for firms have been used.[24] This policy function says that savings (and investment) are a constant fraction of total GDP. Using (10), the output path for an

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

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Note that this investment policy function is independent of the social security tax rate. The reason is that it is a tax on wages. Since interest income is not taxed, the social security tax does not distort Intertemporal investment decisions. Since most social security programs around the world are financed with wage taxes (see fact 1f in section 1), this assumption is not too unrealistic. Another important assumption of the model is that agents are not allowed to choose the amount of time they work (that is, there is no leisure choice). If a leisure choice was introduced, higher social security taxes would reduce work effort and, as a result, would reduce the amount of output under social security. This clearly biases the quantitative results in my favor. However, the qualitative results of the paper would still be valid if a leisure choice was introduced in the model (the only difference would be that the externalities and depreciation rates necessary to make social security desirable would have to be higher).

economy where all people work is described by the following difference equation

$$(11)\quad \ln Y^{all}_{t+1} = \eta + \alpha \ln Y^{all}_{t} + (1-\alpha+\epsilon_j+\epsilon)\ln(n^{y}_{t+1}h^{y}_{t+1}+n^{o}_{t+1}h^{o}_{t+1}) - (\epsilon_j+\epsilon)\ln(n^{y}_{t+1}+n^{o}_{t+1})$$

where $\eta=\alpha\ln(\alpha/(1+\rho))$ 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

$$(12)\quad \ln Y^{ss}_{t+1} = \eta + \alpha \ln Y^{ss}_{t} + (1-\alpha+\epsilon_j+\epsilon)\ln(n^{y}_{t+1}h^{y}_{t+1}) - (\epsilon_j+\epsilon)\ln(n^{y}_{t+1})$$

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

(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

$$(14)\quad (\gamma_y^{all})^* = \frac{1-\alpha+\epsilon_j+\epsilon}{1-\alpha}\,\gamma$$

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

$$(15) \qquad (\gamma_y^{SS})^* = \frac{1-\alpha+\epsilon_j+\epsilon}{1-\alpha}\gamma$$

Note that $(\gamma_Y^{all})^*=(\gamma_Y^{ss})^*$, 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. We just showed that the two growth rates are the same so the steady-state difference in the log of output is constant. This difference is given by

$$(16) \qquad [\ln(y_t^{all}) - \ln(y_t^{ss})]^* = \frac{1-\alpha+\epsilon_j+\epsilon}{1-\alpha}\ln\left(\frac{n^o}{n^y}\frac{1-\bar{\delta}}{1+\gamma}+1\right) - \frac{\epsilon_j+\epsilon}{1-\alpha}\ln\left(1+\frac{n^o}{n^y}\right)$$

Equation (16) suggests that if there are no externalities ($\epsilon_j=\epsilon=0$), the 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^o) are large enough, then total output in the economy where all work is lower than the total output produced when the elderly retire. In other words, output can be increased if the elderly retire.

(3a) Private or Public Retirement Schemes?

An important question is whether retirement schemes should be introduced by the government or by the market. The answer according to the model depends on what type of externality is important. 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 without the need for government intervention.

If the inter-firm externality is important, however, retirement would yield higher aggregate, but 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.[25]

Obviously in the real world there could be both intra-firm and inter-firm externalities. As

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In a set of clever and original papers, Lazear (1979, 1983) outlined 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, desirable. Lazear's story explains why private firms would like the elderly to retire. It does not explain, however, why in most countries, it is the government that organizes large-scale social security programs that provide the incentives for retirement.

a result, we should observe both privately-induced as well as publicly-induced retirement schemes. The important point, however, is that as long as the inter-firm externalities are large enough, government intervention will be necessary.

(3b) Transfers versus Taxes as a Means to Induce Retirement.

This paper provides an explanation as to why it may be desirable for the government to induce the retirement of old workers. The question is what is the best way to achieve this goal. There are different ways to induce the elderly to retire. One of them is an age-related income tax. In terms of the model, a 100% (or higher) tax rate on the wage of the elderly would make all workers earn their social marginal product so efficiency would be achieved.

Another way to achieve the same outcome would be to devise a clever transfer scheme: the elderly could be given some transfers, conditional on them not working. Note that this is what we observe in the real world. Algebraically, let T be the transfer received by the elderly. This transfer would be equal to some large amount TR if they decide not to work ($n^o=0$),[26] and would be some small amount σ (where $\sigma < TR$) if they decide to keep working ($n^o>0$):

$$(17) \qquad T = \begin{cases} TR & if\ n^o = 0 \\ \sigma & if\ n^o > 0 \end{cases}$$

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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.

If TR is large enough relative to σ,[27] 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 $n^o=0$) depends on whether they like their jobs or not. If they are indifferent between working or not working (as they are in this model since they have no preference for leisure time), the required transfer would be the wage they would earn if they worked: 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, then the transfer would be smaller than the opportunity wage ($TR<w^{o,all}+\sigma$). If they like their jobs, then the required transfer would be above the opportunity wage.

Most governments in the world choose the social-security/transfer scheme over the age-related tax system as a way to induce retirement. The model in this paper does not explain why this is the case: under the assumptions of the model, the two strategies are equivalent. The model could be amended in different directions to show why transfers or why taxes are a better strategy. For instance, if we introduce a leisure choice so that wage taxes are distortionary, we will conclude that the age-related tax system is better. On the other hand, if we introduce other types of distortions , the second-best solution would make the rationing-subsidy scheme better than the market-tax scheme as suggested by Guesnerie and Roberts (1984). We could also introduce 'anti-discrimination' legislation into the model (this is certainly a feature we find in the real world), to argue that a social security transfer scheme is superior: an age-related tax system

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The difference between TR and σ could be thought as the tax on the pension when the person works. In the United States, the marginal tax on pensions for elderly whose labor income exceeds $7,444 (in 1992) was 50%. In some countries, no pension can be collected if the person works. The value of σ in this case would be zero.

could be seen as discriminatory and, as a result, socially or politically undesirable. It is not hard to imagine the political problems that one would have in the United States if one were to propose different tax rates based solely on age differences.[28]

(3c) Retirement or relocation?

I have been assuming that output was a good measure of social welfare and that the elderly could not form a firm or a division where they could 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 aged 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.

To some extent, this kind of sorting process already happens. For example, the great majority of the attendees at the NBER Summer Institute are quite young compared with the average age of academic economists. Meeting away from the elderly is one way to avoid the externalities. In Japan, workers are assigned to a different divisions of the company as soon as they reach a certain age.[29] But to the extent that full sorting is not a possibility (maybe because young workers are a necessary input of production, maybe because everybody must go to faculty

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[28] The question would then be why are there anti-discrimination laws at all. This paper provides no answer to this important question. But taking them into account seems important because, as discussed in section 1, one of the reasons why Senator Wagner's proposed Railroad Act was declared unconstitutional by the Supreme Court in 1934 was that it discriminated people by age as it did not allow old workers to work if they desired to do so.

[29] In the United States, people are assigned to a completely different state called Florida.

meetings), aggregate output will be higher under social security.

But even if was possible to increase aggregate output by confining the elderly to some new job, it is not clear that social welfare would also be higher. This would be particularly true if (1) the elderly valued leisure, (2) they were not very good at performing these new jobs (for which they have not been trained), and/or (3) it were costly to adjust from their previous jobs. In other words, we should consider that a person may not like to start flipping burgers at McDonald's after being the president of an international corporation or a professor of economics at Yale. He will probably prefer to enjoy leisure instead. Hence, even though aggregate output would be higher if he worked at McDonald's, to the extent that society values his utility, it will be better to retire him rather than to relocate him.

(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?[30] Why are social security systems created only after a certain level of development has been reached?

To answer these questions consider two economies that, at time zero, have the same level

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Social insurance programs through history have usually been left to other institutions such as churches, families or villages. Government-sponsored social security schemes are fairly recent innovations (see discussion in section 1).

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

$$(18) \qquad \ln(y_0^{all}) - \ln(y_0^{SS}) = \frac{1-\alpha+\epsilon_j+\epsilon}{1-\alpha} \ln\left(\frac{n^o}{n^y} \frac{1-\delta(h^y)}{1+\gamma} + 1 \right) - \frac{\epsilon_j+\epsilon}{1-\alpha} \ln\left(1+\frac{n^o}{n^y} \right)$$

All the terms in equation (18) 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 $\ln(Y^{all})^* < \ln(Y^{ss})^*$.

The transitional paths of aggregate output for the two economies are described by equations (11) and (12). We can solve for the time paths numerically. Figure 1 reports 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 parameters are the same, the only difference between these two economies is, therefore, that in Y^{ss} the elderly do not work. There is a point in time $\hat{t}$ at which the two time paths cross. At this point, aggregate output with and without social security coincides. For t $< \hat{t}$, the economy without social security produces more output. Hence, we should not expect to observe a social security system before $\hat{t}$. For t > $\hat{t}$, aggregate output is higher when the elderly do not work so we should expect a social security scheme to be created around $\hat{t}$.

The economic intuition behind this result is the following: 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. As we argued above, when the skills of all workers are similar no worker exerts negative effects on the rest of the workers so output is higher when all work. As human capital accumulates and technologies 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: the introduction of legislation to buy the elderly out of their jobs will look desirable.[31,32]

One prediction of the model is that, around the time when social security is introduced (that is, around $\hat{t}$), the economy with social security grows faster.[33] We can see in Figure 1 that

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Anticipation effects are neglected in that it is 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 transfers (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).

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Another plausible story that would explain the creation of social security in the XIX century and not earlier is that the externality was not important before the industrial revolution: the type of intellectual interaction that generates the human capital externalities described in this paper would probably not apply to agricultural economies. In terms of the model, it is possible that the parameters ϵ and ϵ_j increase with the level of development (ie, $\epsilon(h)$, $\epsilon_j(h)$ with $\epsilon'>0$ and $\epsilon_j'>0$).

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Asymptotically, however, the growth rate of the economy with social security economy will be

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, if the economies in the data are within a reasonable range of $\hat{t}$, then the model predicts a positive relation between social security transfers and growth so it will appear as if transfers were productive. And in a way they are because "buying the elderly out of their jobs" could be thought of as an input of production that increases aggregate 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 life expectancy and dependency ratios (the ratio of the number of old to young people.) This section explores the effects of such changes in the population structure social security.[34]

(5a) Increase in Life Expectancy

In order to introduce changes in life expectancy in the simple model with 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

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the same as the economy without.

[34] In the analysis above, it has been 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.

the oldest possible ages, I. An increase in life expectancy works like an increase in I. Of course for ages after the peak in human 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.

Figure 2 plots the time paths of two economies. The parameters are chosen so 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 consistemt with the creation of social security programs after an increase in life expectancy.

(5b) Increase in the Dependency Ratio.

We now examine 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 3, the time paths for $\ln(Y^{ss})$ and $\ln(Y^{all})$ are displayed. The two southernmost paths refer to a situation where the population structure is constant throughout. Note that they cross 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. The third path has been drawn under the assumption that at

some time $t' > \hat{t}$, 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). After this moment we observe that path B shoots way up and crosses zero at time t". In other words, if after social security is created, the dependency ratio suffers a sufficiently large increase, the pension system is no longer desirable. The intuition 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.

(6) Conclusions and Extensions.

In this paper I made two simple points. First, I argued that in most countries, social security benefits can be collected only after the person retires (or, in some countries like the U.S., there are severe penalties for earning labor income, although not other types of income.) This suggests that the social security system puts great emphasis on retirement and that social security theories should explain why the government seems so interested in retiring the elderly. Second, I provided a theory that is consistent with this regularity. The main idea is that social security is just a way to buy the elderly out of their jobs, that is 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. This idea was modeled through **positive** externalities in the **average** stock of human capital. Since human capital depreciates with age, old workers have lower-than-average human capital and, as a result, they exert a negative effect on the productivity of the young. When the difference between the skill level of the young and that of the old is large enough, aggregate output in an economy where the elderly do not work is higher. Social security systems arise as a means to achieve this end.

This explains why, in most countries, the elderly can collect their pensions only after they retire.[35]

I also argued that, unlike other branches or government (like defense), social security programs were not introduced until a certain level of development had been reached. That is, social security appears to be a luxury good. In Section 4 I show how a social security system is created endogenously as the economy reaches a certain level of income. The economic intuition behind this result 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 the young and that of the old is not large enough to warrant the introduction of retirement schemes. As the economy develops, the rate at which new technologies are introduced increases and, as a consequence, so does the rate of human capital depreciation. Accordingly, the gap between the skill level of the young and the old increases. There is a point at which this gap is large enough so that it pays a society to introduce a social security system.

The model is also consistent with a number of other empirical regularities (also documented in section 1): people have to work for a number of years prior to being able to collect pensions (the reason is that people who do not have jobs do not have to be bought out of the labor force); pensions are linked to previous wages (the higher a person's previous wage is, the higher the payment required to induce him to abandon his job); social security programs enjoy widespread support (because income is higher for all agents in the economy); and social security

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The close relation between pensions and retirement suggests that we should not study the desirability of such transfers without, at the same time, studying the desirability of retirement: before deciding whether pensions are a bad thing to have, one needs to imagine what the world would look like if, suddenly, most people between 65 and 95 started working...or did not abandon their tenured jobs!

programs are created irrespective of the political system (as long as political leaders or other voters favor higher levels of aggregate income, buying the elderly out of their jobs will be desirable.)

Even though it does not 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 as people get older, the gap between their skill and that of the young gets wider so the need for retirement also increases.

Finally, the model predicts that when the dependency ratio increases, the desirability of any given social security program falls. Hence, given the recent population trends in the United States, the debate surrounding the potential elimination of the social security program does not seem entirely unreasonable.

Throughout the paper a number of shortcomings and interesting extensions to the analysis were highlighted. The model was fairly aggregative in at least three ways. First, it had only one sector. In the real world, jobs in different sectors require different skill levels and the rates at which these skills depreciate over time are also likely to differ across sectors. Likewise, human capital externalities are probably more important in some sectors than in others. One could extend the model to embrace a multisectoral world along these lines. The main conclusions, however, would not change: retirement in a particular sector would depend on how fast the skill level depreciates with age, and on 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 Dupont 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 (intra and/or inter-firm) seem important and where, due to the continuous tension and stress at work, skill depreciation is probably high. Another example of a profession where externalities and depreciation rates are large is that of the commercial air pilot. As expected, air pilots are forced to retire at a fairly young age (and they are forced by government regulation).

A second source of aggregation was that there were only two types of people: young and old. This did not allow for the discussion of the optimal retirement age, and how this age would change in response to changes in some of the demographic conditions analyzed in section 5. Of course the conclusion that it is optimal to terminate any given 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 (as has occurred in the United States.)

In addition, a richer population structure would also allow for an examination of how these retirement schemes affect the incentives to accumulate human capital when young and, therefore, how they influence long-run growth. The direction in which social security schemes affect growth is not clear a priori: On one hand, early retirement shortens the period during which one can work, so it lowers the overall rate of return to human capital. On the other hand, the elimination of the elderly from the labor force increases the wage for the young, so social security increases the rate of return to human capital. The overall effect is ambiguous.

Furthermore, a model where children were introduced into the analysis would predict that, as the gap between the level of skill of children and young adults increases, it would become more desirable to remove children from the labor force. This would explain the introduction of

minimum working-age requirements, mandatory schooling and the existence of minimum wages (which tend to hurt the employment opportunities of the young and the unskilled). These two phenomena are fairly recent (XXth century) and are more important in rich countries.

A third source of aggregation is that all people of the same generation were assumed to have the same skill level. Obviously in the real world there is a wide variety of skills across people of the same age. A strict interpretation of the model would say that transfers to poor people are simply part of the same scheme: poor people tend to be less skilled and, therefore, there is a greater need for their exclusion from the labor force. **Welfare programs, minimum wage laws**, and other types of regulation would also tend to work in this direction.

The final point is that the model presented in this paper relies on the assumption of human capital externalities in production. Some readers may not like this assumption and one must confess there is limited evidence on the existence of such externalities (despite their widespread use in the modern theories of endogenous growth). Following Friedman's methodology of positive economics, we should not care about the assumptions made but, rather, on whether the model can explain the existing evidence. And in this regard, one should view this paper as presenting a puzzle to the existing theories of social security: why is it that most social security systems around the world so heavily link pensions to retirement? Whether one buys the exact explanation provided in this paper or not, the message is that researchers should focus more on the theoretical relation between pensions and mandatory retirement.

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Figure 1: Time Paths

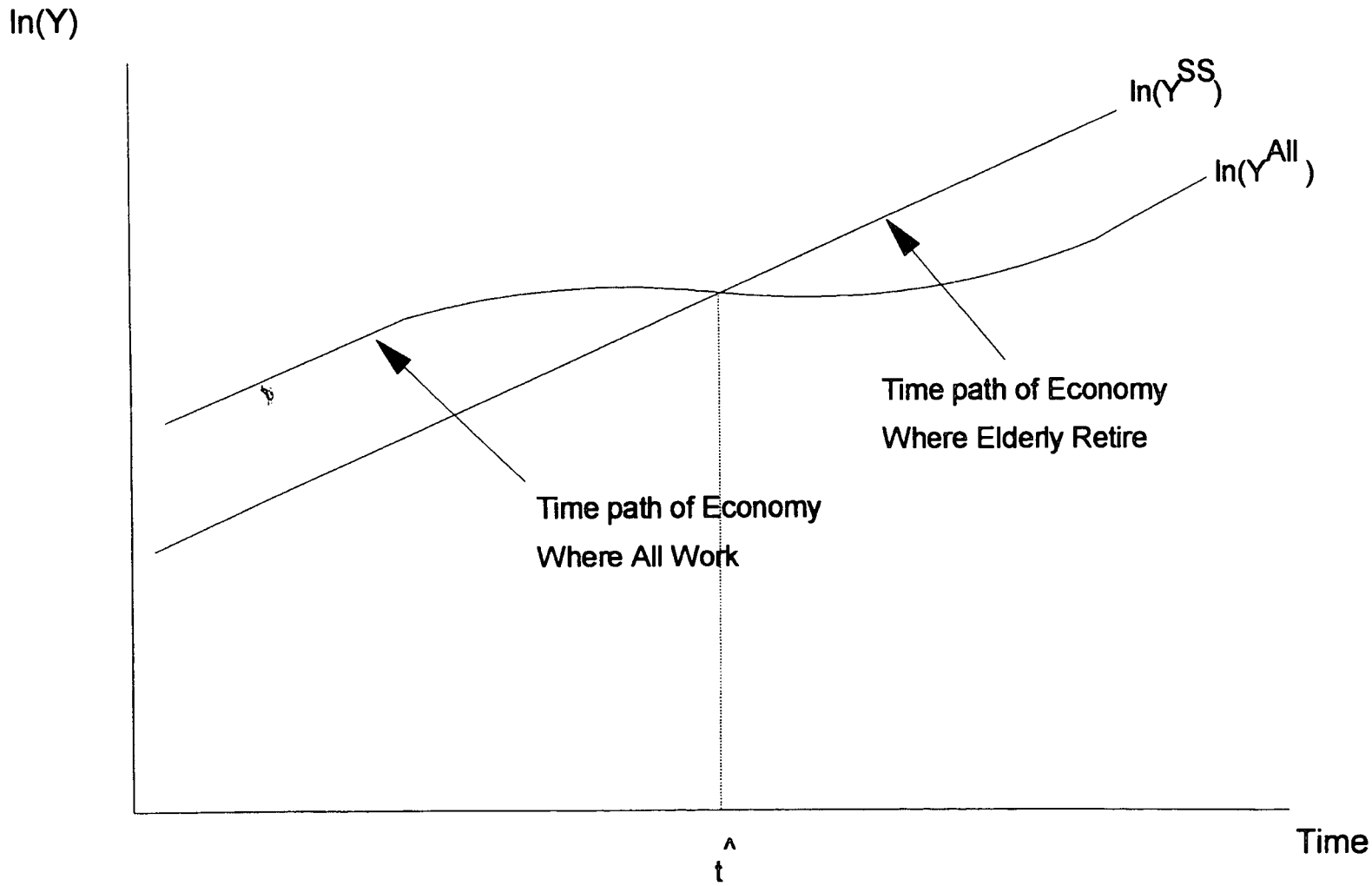


Figure 2: Increase in Life Expectancy

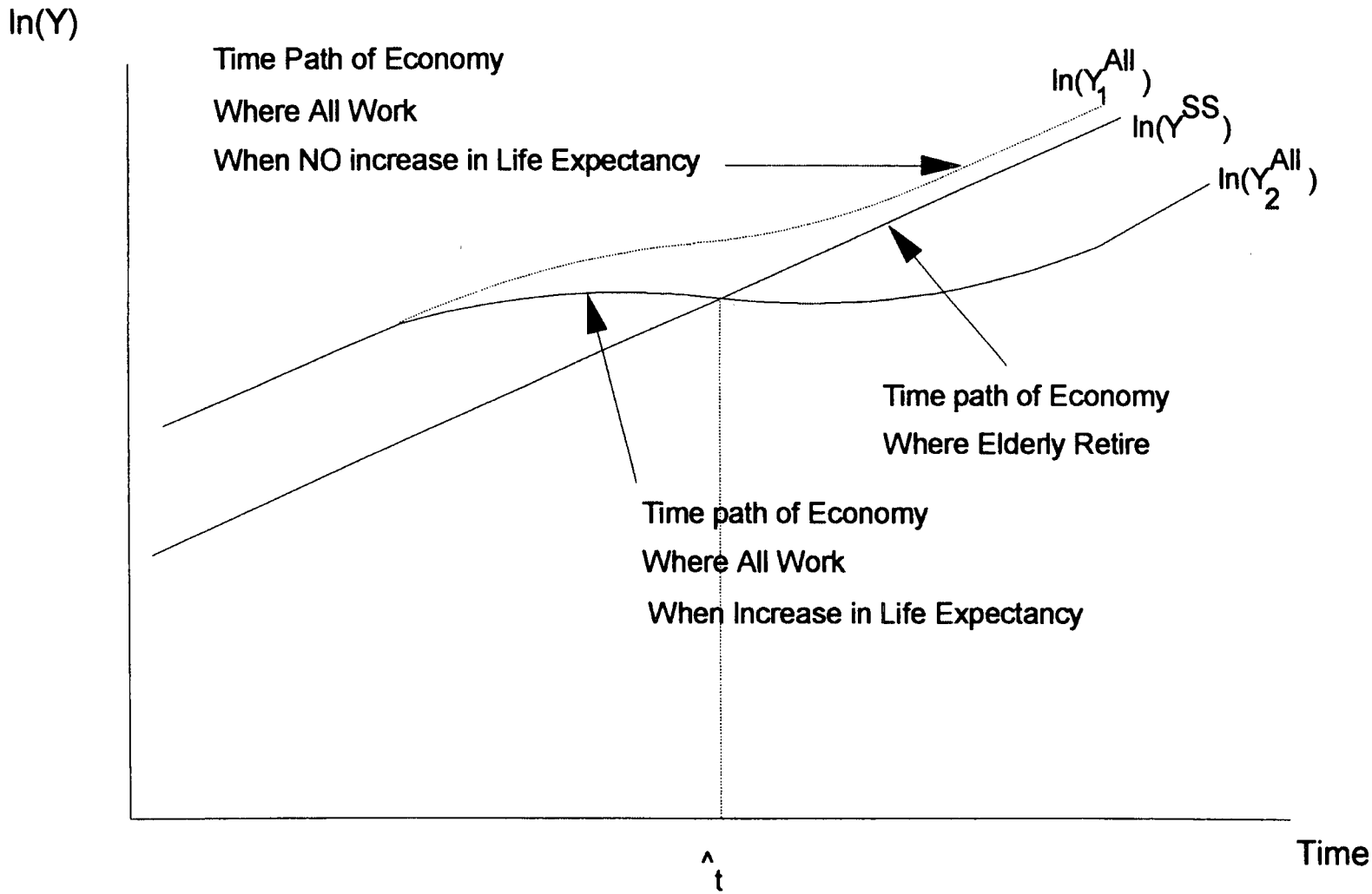
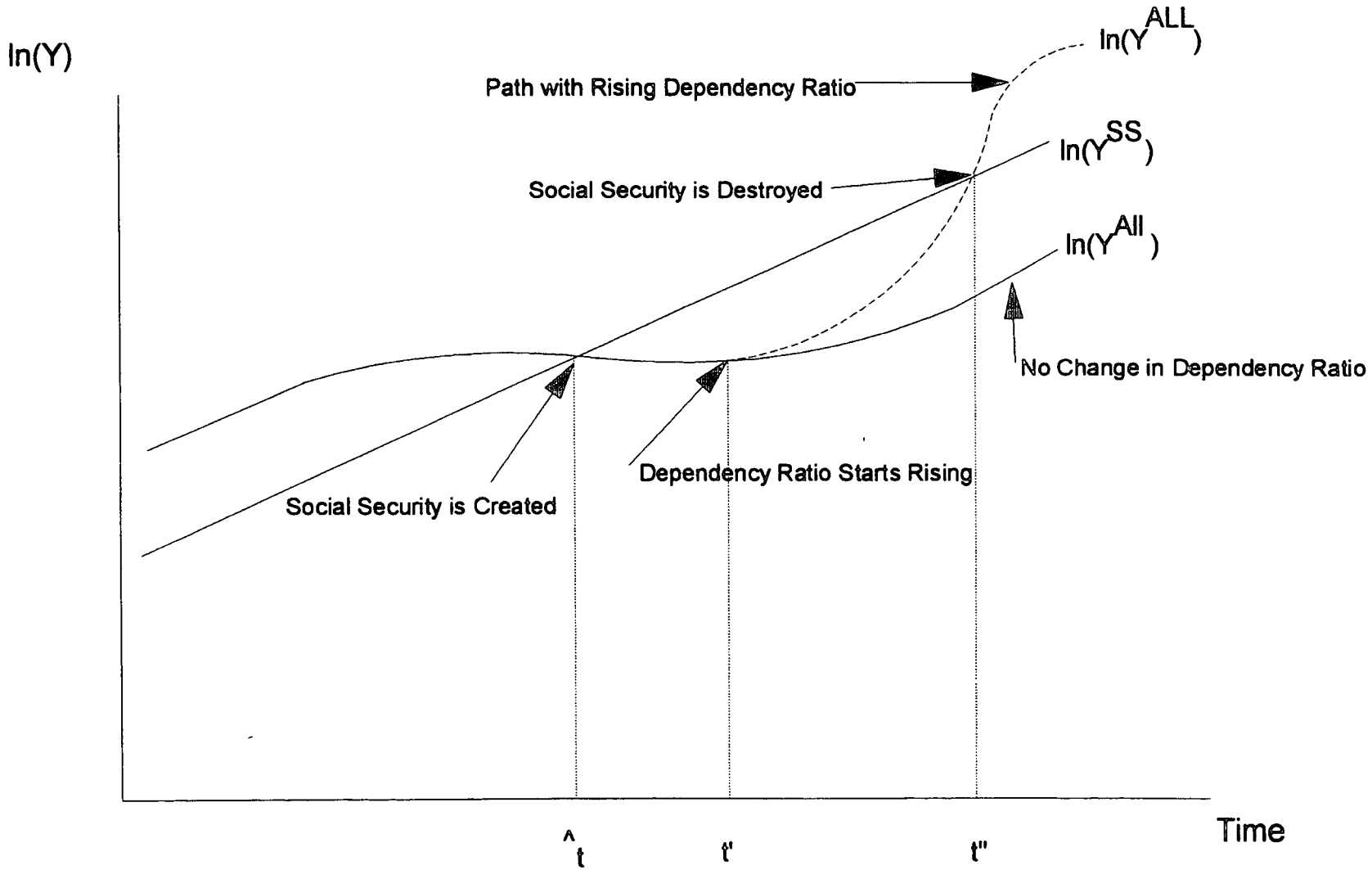


Figure 3: Increase in Dependency Ratio



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