School of Management and Economics at Lund University

The Department of Economics

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Long Term Fiscal Implications of subsidizing *In-vitro* Fertilization in Sweden.

–A study using Net Present Value.

Abstract

Today, almost three percent of all babies born in Sweden are conceived with the help of *in vitro* fertilization (IVF). Nonetheless, studies indicate that IVF is underproduced by society and the Rand Corporation concluded in a recently published report that IVF has the potential to increase fertility rates in Europe. If IVF is considered as a method to improve fertility rates, reimbursing IVF could arguably be seen as an investment in demographic structure by the Swedish Government. The present study aims at evaluating the long run net fiscal implications of subsidizing IVF during the assumption that it is seen as an investment in population structure. A simplified model was developed to calculate the net present discounted value (NPV) of a successful IVF treatment to the Swedish government. The model describes relevant financial interactions between a hypothetical individual and the State throughout the individual's life. Based on average life-expectancy (age 80) in Sweden the model indicates that an individual born in 2005 after IVF-treatment returns a lifetime positive NPV to the government of 254 000 SEK with a break-even point (the age at which a positive NPV is achieved) at age 41. Despite the obvious difficulties that lies in predicting future payments during a 80 year long investment one important observation sustains: the costs associated with IVF treatment is relatively insignificant vis-à-vis other costs and benefits to the government. The model is not sufficiently sophisticated to provide an adequate forecast of the full economic costs and benefits associated with subsidizing IVF. However, it does show that in the long run, subsidizing IVF is not a burden to the State budget; on the contrary, the IVF-offspring returns a net positive value to the Swedish State.

Keywords: IVF, NPV, Demographic Structure, Fertility, Fiscal budget.

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Contents

Introduction

Today, almost three percent of all babies born in Sweden are conceived with *in-vitro* fertilization (IVF) (Swedish National Board of Health and Welfare, 2007 and Statistics Sweden, 2007). Nonetheless, studies indicate that IVF is underproduced by society and the Rand Corporation[1] concluded in a recently published report that IVF has the potential to increase fertility rates in Europe (Neumann and Johannesson, 1994; Granberg et al., 1995; Ryan, 1997; Neumann, 1997; Grant et al., 2006). If IVF is to be considered as a method to improve fertility rates, reimbursing IVF could arguably be seen as an investment in demographic structure by the Swedish government. However, as the State, just as any other company or individual, faces scare resources the costs and benefits of IVF-reimbursements must be evaluated. Consequently, there have been studies concerning the cost of IVF for the Swedish government in terms of how much the government spends on IVF each year (Granberg, 2004). Yet, the State always faces a binding constraint; given the tax and transfer system a governments' budget must be balanced in the long run. Therefore, it is also important to evaluate how an investment in IVF impacts the State budget in the long run. The ambition with this thesis is to study the costs associated with IVF in a longer perspective and how these costs affect the State budget. Therefore, a Net Present Value (NPV) calculation will be used to asses whether investing in IVF leads to a budget burden for the State. Thus, the purpose of this thesis is to study the long run net fiscal implications of subsidized IVF-treatment under the assumption that it is seen as an investment in population structure.

Background

Assisted Reproduction Technology

When the first IVF baby was born in 1978 it was also the birth of a new medical technology, Assisted Reproduction Technology (ART) (Neumann, 1997). Since then, the technology has continuously been developed and improved, and the number of babies born with the aid of ART has increased dramatically. In Sweden, in 2004, 12 798 treatment cycles were started which resulted in 2 690 deliveries (Swedish National Board of Health and Welfare, 2007).

[1] The Rand Corporation is an independent, non-profit think-tank. www.rand.org

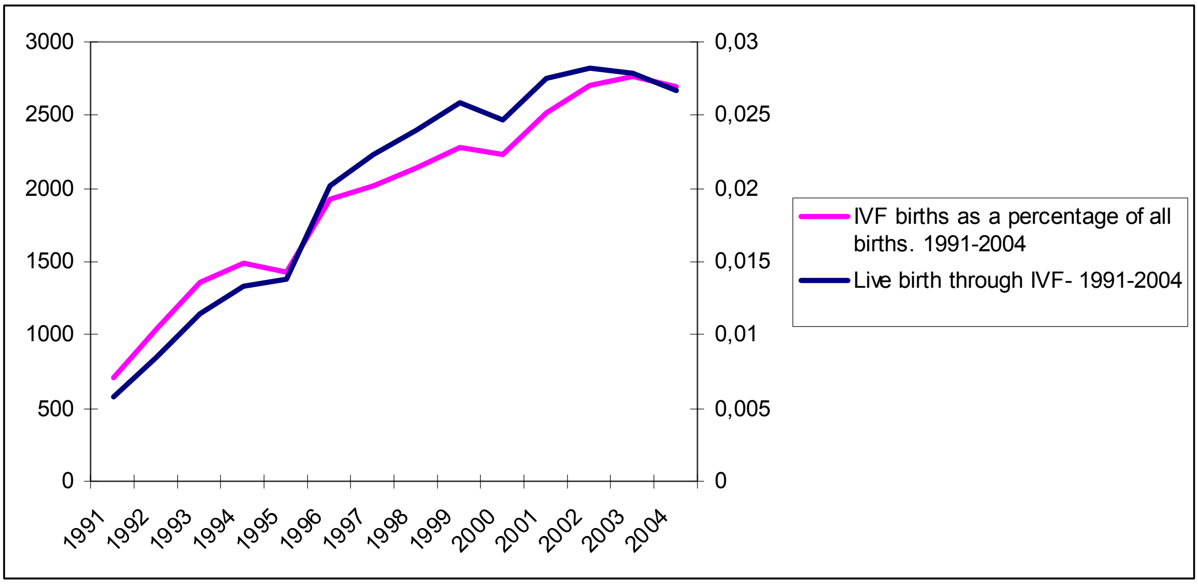

Figure 1. Number of deliveries through IVF in Sweden and the ratio IVF births/all births. 1991-2004. Source: Statistics Sweden (2007a) and Swedish National Board of Health and Welfare (2007).

The term ART includes a variety of techniques but all techniques have in common that fertilization occurs outside the body i.e. *in vitro*. During standard IVF, the first method introduced, oocytes[2] are removed after hormone treatment, which stimulates the ovaries to produce and release oocytes (Sunde, 2007). The oocytes and sperm cells are then brought together *in vitro* and fertilization occurs spontaneously. After fertilization, the fertilized embryo is transferred to the uterine cavity for implantation. When semen quality or quantity is inadequate making traditional IVF inefficient, Intracytoplasmic Sperm Injection (ICSI) can be used. During ICSI, a single sperm is injected into the oocyte. The term ART also includes frozen embryo replacement (FER) and oocyte donation (OD). During FER an embryo is frozen and preserved to, at a later date, be thawed and transferred to the uterus. In Sweden frozen eggs are generally allowed to be preserved for five years (Swedish National Board of Health and Welfare, 2007). In 2003, OD became accepted by the Swedish law. Both anonymous and known/identified donors are allowed.

In this paper the term IVF will be used synonymously for all ART-techniques. A complete treatment cycle of IVF is defined as the completion of drug induced ovarian hyperstimulation, harvest of oocytes from the ovaries and subsequent implantation of the embryo (Sunde, 2007).

[2] An oocyte is a cell which later develops into an ovum, or egg cell.

Side effects

The main side effect with IVF is a higher rate of multiple pregnancies (Swedish National Board of Health and Welfare, 2007). This is cause of concern since it increases the risk of pre-term labour and consequently, low birth weights. The frequency of malformations is also somewhat higher among IVF-children. Accordingly, both mortality and morbidity is increased among IVF-infants. The higher multiple pregnancy rate is a consequence of the replacement of more than one fertilized embryo at the time, in the interest of maximising the probability of pregnancy. However, the rate of multiple pregnancies is decreasing. In 1991, as much as 32.1 percent of all IVF-pregnancies in Sweden resulted in multiple births. The rate has since then steadily been decreasing and in 2004 6.5 percent of the IVF-pregnancies resulted in either twins or triplets. The decreased rate can be explained by the successive decrease in the number of embryos replaced. Today, single embryo transfer is standard and is in accordance to the guidelines of the Swedish Board of Health and Welfare. Moreover, data demonstrates that women treated with IVF are generally older than the average women giving birth and this may have an effect on the statistics as risks associated with pregnancy and labour increase drastically by maternal age. Thus, adjusting the data for age may produce a somewhat lower ratio of multiple birth and pre-term labour among IVF-births (Swedish National Board of Health and Welfare, 2006a). Among spontaneously arisen pregnancies the rate of multiple births is around one percent.

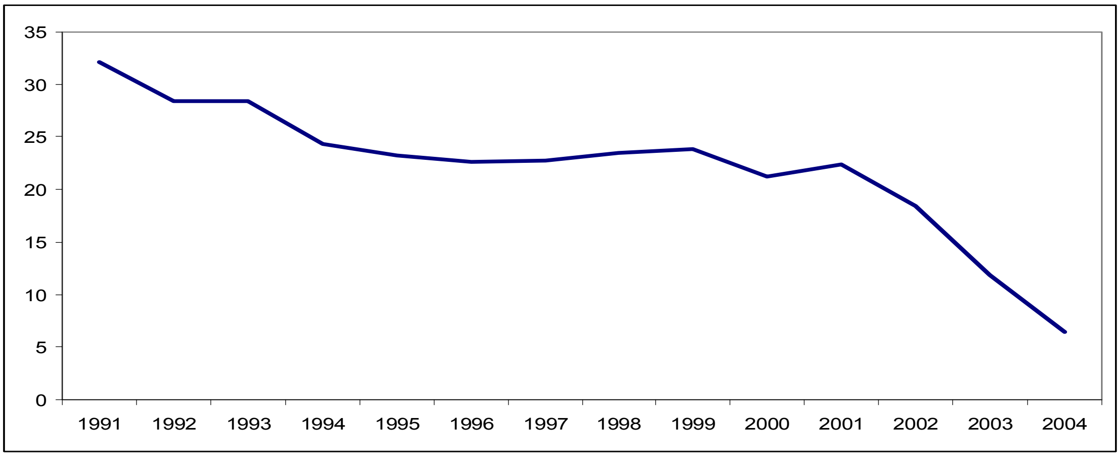

Figure 2. The rate of multiple births after IVF-treatment as a percentage of all IVF-deliveries, 1991-2004.
Source: Swedish National Board of Health and Welfare (2007)

Economic implications of IVF

State funding of IVF-treatment.

Sweden has a publicly funded health care system and the ethical platform for prioritising health care rests on three basic principles; (1) the principle that all humans have the same value; (2) the principle of need and solidarity which means that resources should be used where they are needed the most; (3) the principle of cost-effectiveness (SOU, 2001). With these guiding principles, four priority groups are established, ranking infertility in Priority group III (out of IV) (SOU, 1995). As infertility is included on the priority list, IVF treatments at public clinics are fully reimbursed by the National health care system (Granberg et al., 1998). However, the National health care system has set limitations for the number of IVF-cycles covered by the system and which indications allow couples treatment. In addition, as the waiting-lists for treatment often are long many couples turn to private clinics. The costs of treatments performed at private clinics are not reimbursed. The costs of drugs are reimbursed to 95 percent irrespective of whether the treatment is publicly or privately funded (Granberg et al., 1998). In 2001, approximately 68 percent of the total expenditure on IVF-treatment in Sweden was publicly financed and Granberg (2004) estimates that the total public costs of IVF-treatment in 2001 correspond to 0.14 percent of the total healthcare expenditure in Sweden.

How much is the public ready to spend on IVF?

One way of valuing IVF is to estimate what couples are willing to pay for the procedure. The Willingness To Pay-technique (WTP) is based on the premise that the maximum amount of money an individual is willing to pay for a good or service is an indicator of the value to him/her of that good or service (Ryan, 1997). Thus, public provision of IVF should be encouraged up to the point where government expenditures equal the benefits of IVF (or what the public is willing to spend). Studies on WTP of IVF suggest that the public generally give a high economic priority to IVF-treatment. For example, Ryan (1997) reported that the average user of IVF in Aberdeen, Scotland were willing to pay £5000 per cycle whereas government expenditure was £2700. Granberg et al. (1995) came to a similar conclusion surveying couples about to start IVF treatment in Gothenburg, Sweden. The survey showed that the majority of the couples were willing to pay more for a child than the calculated direct costs associated with IVF. Neumann and Johannesson (1994) reported that survey respondents in

Boston, Massachusetts, USA, would pay an average of $17730 for IVF if they were infertile and the procedure had a ten percent chance of success. In an earlier study, Neumann (1993) concluded that individuals were willing to pay substantial amounts so that others would have access to IVF. The responders were willing to pay $32 per year in taxes for a hypothetical public program of IVF which would provide twelve hundred couples per year, IVF treatment. The economic benefit of such program, measured as total societal willingness to pay, would far exceed its costs (Neumann, 1997).

Some of these above stated studies were performed on IVF-treated couples and therefore it is reasonable to assume that they are more likely to be willing to pay more for a child than the average individual. Yet, these results suggest that many individuals exhibit altruistic attitudes towards IVF and that IVF may be underproduced by society in terms of a socially optimum level of IVF services.

IVF – an investment in demographic structure?

The Potential of IVF-the RAND study

A great concern of every nation in the European Union is the fact that the Total Fertility Rate (TFR) is below replacement level, usually considered the 2.1 children per woman needed for a population to replace itself (Eurostat, 2006). Italy, Spain and Greece being the countries worst off with fertility rates around 1.3. Sweden is relatively well of with a TFR at 1.77 (Statistics Sweden, 2006) which is however, still significantly below replacement level. This is an area of concern since declining birth rates will have a significant influence on age structures. In 2000, one in six Europeans was above 65 years old, by 2050, every third individual will be above the age of 65 (Grant et al., 2006). A high dependency ratio (pensioners/working population) is associated with a range of problems. Contributions from the working population to health, pensions and welfare funding will decline just as the need is increasing (Hoorens et al., 2007). For example, Mckinsey estimated that, given the expected population structure in 2050, if Germany want to maintain its' current benefit level, taxes needs to be increased by approximately 90 percent (Mckinsey, 2006).

A recently published report by the Rand Corporation discusses the issues of population aging (Grant el al., 2006). The report suggests that one way to offset an aging population is by encouraging child-bearing. This can be implemented by introducing policies such as flexible working, maternity and paternity leave and increasing benefits for the second and third child.

These policies can affect birth rates by encouraging parents to have more children than they would otherwise have if these policies had not been in place. Furthermore, the report brings forward the option of widening the availability of IVF as a method to increase fertility rates. In the report, Rand evaluates the effect of IVF on TFR in the UK if the UK were to increase the number of IVF-cycles to the level performed in Denmark 2002. The study concluded that the UK could raise TFR from 1.64 children per women to 1.68. This increase may sound insignificant but the effect is comparable to a 25 percent raise in child benefits. Moreover, the study suggest that if all sub-fertile[3] women were offered IVF and adopt the fertility rate of fertile women the TFR in the UK would increase by 0.22 to 1.84. Thus, IVF has a potential to increase fertility as a mean to partly offset population aging. In that context, if the government subsidize IVF as a method to improve TFR it can be seen as a State investment in demographic structure.

[3] Unable to conceive naturally but may be able to conceive with IVF-treatment.

Method

Qualitative description

The model

This model quantifies the fiscal impact of the cost of subsidizing IVF by using a NPV-calculation. The model describes the lifetime financial interaction between the State and a hypothetical individual born in 2005 with a life expectancy of 80 years[4]. The individual is assumed to be conceived with IVF. In this contract the person pays money into the State budget through tax (positive cash flow for the State), while the State pays for some services on behalf of the person (negative cash flow for the State).

Thus, the model studies the financial balance of a person's interaction with the state throughout the duration of the individuals' life. At any time, the balance or net return, N_L, to the state is given by:

$$N_L(t) = T(t) - C(t) - E(t) - H(t) - G(t) - P_S(t)$$

Where $T(t)$ is the tax revenue of the State; $C(t)$ $E(t)$, and $H(t)$ are the costs of child allowance, education, and healthcare, respectively, to the State, while $G(t)$ is the cost of geriatric care. P_S is the State pension.

In Sweden, the Federal Government, the Counties and the Municipalities have separate budgets as well as separate areas of responsibilities. This is ignored in the model and all three forms of government are assumed to be one unit.

At birth, the new born costs a sum, *Ch*. Since the baby is conceived through IVF, a further cost, *IVF,* is added. In this context, the State can be seen to make an investment, which in time will lead to a return with Net Present Value:

$$NPV(t_0) = \int_{2005}^{2085} D_Y dt - IVF - Ch$$

Where $D_Y = N_L D_F$ and $D_F = \frac{1}{(1+r)^t}$

Where r is the discount rate and t=0 is assumed to be year 2005.

[4] In 2005 life expectancy in Sweden was 78.4 years for men and 82.8 years for women. (Statistics Sweden, 2007b)

Life stages

During the early stages of the person's life the State contributes towards his/her education and healthcare costs. Then the individual enters their working life. In this stage, although the State still contributes to healthcare costs, its balance is positive due to taxation. Finally, after retirement, the State helps to support citizens until the end of their life. See figure 3.

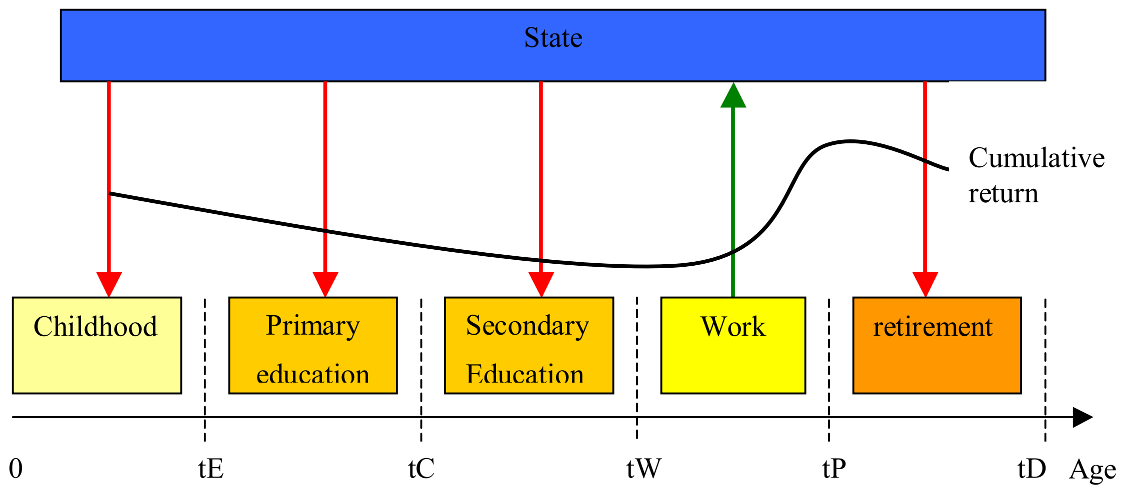

Figure 3. The financial interaction between the State and an individual.

As described in figure 3, the lifetime of the average individual is divided into five distinct stages:

A. From birth to year t_E: infancy stage

B. From year t_E to year t_C: primary education stage

C. From year t_C to year t_W: secondary/higher education stage

D. From year t_W to year t_P: working stage

E. From year t_P until t_D death: retirement stage

The values of the above constants have, in the base line model, been set to t_E=7, t_C=16, t_W=20 and t_P=60. Each stage has very specific characteristics that differ between the stages. Mathematically this implies a different set of equations for each stage:

$$NPV(t_0) = \int_{t0}^{tE} D_Y dt + \int_{tE}^{tC} DYdt + \int_{tC}^{tW} DYdt + \int_{tW}^{tP} DYdt + \int_{tP}^{tD} DYdt - IVF - Ch$$

The model for each stage depends on the functional forms of several variables discussed next.

Discount rate

In the base line model, a discount rate of 2.5% is applied. This corresponds to the recommendations of the Swedish National Financial Management Authority (2007). The agency states that when calculating expected future cash flows of State investments, a discount rate corresponding to the interest rate of government securities with a similar length as the investment, should be used. The current interest rate for long-term real government securities is currently between 2-2.5% (Swedish National Debt Office, 2007).

Economic Growth

Economic growth is a measure of the increase in value of the goods and services produced in an economy. This is taken into account in the model as several parameters (geriatric care, education, child allowance, pensions and income) are set to increase with economic growth. The Swedish economy has since 1950 grown, on average, 2.8 percent annually (Statistics Sweden, 2007c). Correspondingly, in the base line model, it is assumed that economic growth will continue at the same pace. Thus, the growth rate, α, is assumed at 2.8 percent.

IVF-treatment

The cost of IVF treatment is defined as the cost of a successful IVF treatment-cycle, i.e. a treatment that leads to pregnancy and subsequently, live birth[5]. In the model, a cost of 205 000 SEK per delivery is assumed. That figure is calculated from Granberg's (2004) estimation of the costs of IVF per delivery in Sweden 2001 (175 000 SEK) and increased by the assumed growth in healthcare expenditure (γ) to apply to 2005 figures.

Delivery

The cost of delivery is set at 23 939 SEK which corresponds to data from The Swedish Association of Local authorities and Regions (SALA, 2007).The cost represents the weighted average costs of all deliveries in Sweden 2005, including caesarean sections.

[5] For every successful cycle leading to birth, there are a number of cycles which do not lead to pregnancy or birth; the costs of these unsuccessful cycles are included in the costs of a successful IVF-cycle.

Tax

The State receives an income from the individual in the form of tax revenues:

$$T(t) = \beta(I + P)$$

Where T(t) is the total Tax per person, I is Income of which a fraction, β, is paid as tax. P is total Pension, of which a fraction, β, is paid as tax.

Only income tax and Value Added Tax (VAT) are included in the model (as β). Income tax is assumed at 30 percent and VAT is set at 25 percent in the base line model. Thus, the tax rate (β) is 55 percent.

Income

The data on income is based on statistics of the average income in Sweden 2005 (Statistics Sweden, 2007 (d)). Since average income varies significantly over a person's life, the income, *I,* is set to vary over age in accordance to the data. The average income, *I,* is assumed to increase with the rate of economic growth, *α,* over the years.

The governing equation and solution can be expressed as:

$$\frac{dI}{dt} = \alpha I \Rightarrow I = I_0 e^{\alpha t} \delta_I$$

Where I_0 is the average income for each specific age. The term δ_I is a multiplier that takes the value 1 during the period tW to tP, and 0 otherwise. This means that the income term is valid only during the working stage.

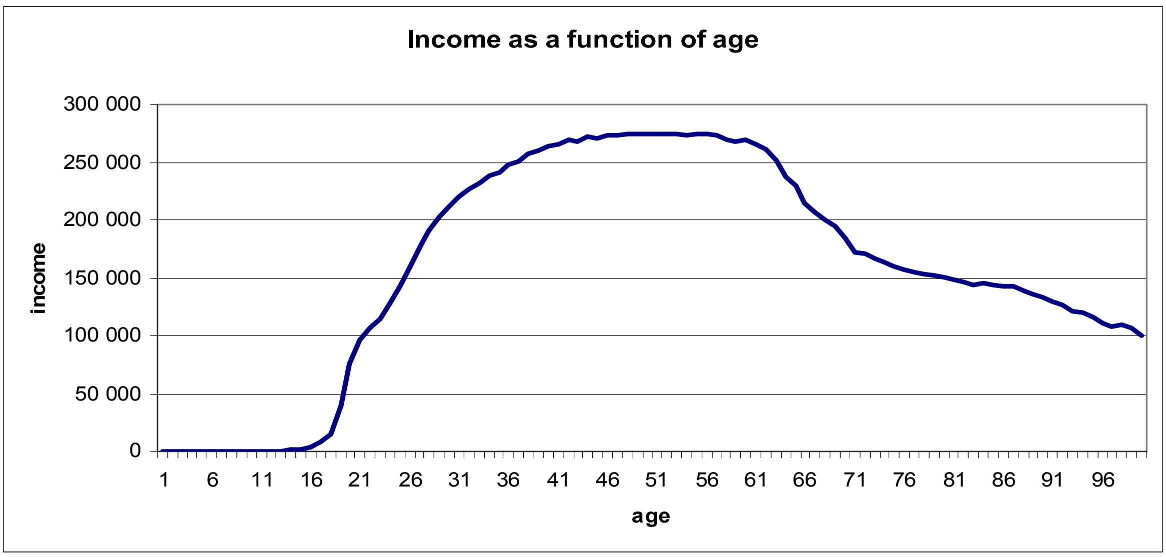

Figure 5. Income as a function of age in Sweden based on 2005 figures. Source: Statistics Sweden 2007

Child allowance

Up to the age of 19, the State provides child allowance for every child in the form of a cash-transfer. The allowance is currently 12600SEK/child/year (Swedish Social Insurance Agency, 2007). In the model, the allowance is assumed to increase with economic growth, α, and can therefore be expressed as:

$$\frac{dC}{dt} = \alpha C \Rightarrow C = C_0 e^{\alpha t} \delta_C$$

Where δ_C takes the value 1 for $age<19$ and 0 otherwise.

Education

The average cost of education is assumed to increase with economic growth (α). The equation is expressed as:

$$\frac{dE}{dt} = \alpha E \Rightarrow E = E_0 e^{\alpha t} \delta_E$$

Where E_0 is the average cost of education in 2005. E_0 varies according to whether the child is in kindergarten, primary education or secondary/higher education. The costs are calculated from data extracted from the Swedish National Board of Education (2007). In this case δ_E takes the value 1 for $age<t_W$, and 0 otherwise. Hence, the costs of education apply only during the stages from birth to working age.

Healthcare

The cost of healthcare is based on statistics from the county of Skåne (Region Skåne, 2006) in Sweden. The data demonstrate that healthcare costs vary significantly over a person's life and this is taken into account in the model by separating health costs by different age-groups. The costs of healthcare can be described by:

$$\frac{dH}{dt} = \gamma H \Rightarrow H = H_0 e^{\gamma t}$$

Where H_o is the average cost of healthcare for each specific age-group. Moreover, in the model, γ reflects the rate at which healthcare spending increases. According to the OECD (2006), healthcare expenditure in Sweden increased, in real terms, by 4.2 percent annually between 1999 and 2004. Thus, the cost of healthcare is growing faster than the economy as a whole. This trend is likely to continue in the future and consequently γ is set at four percent (Bains and Oxley, 2005).

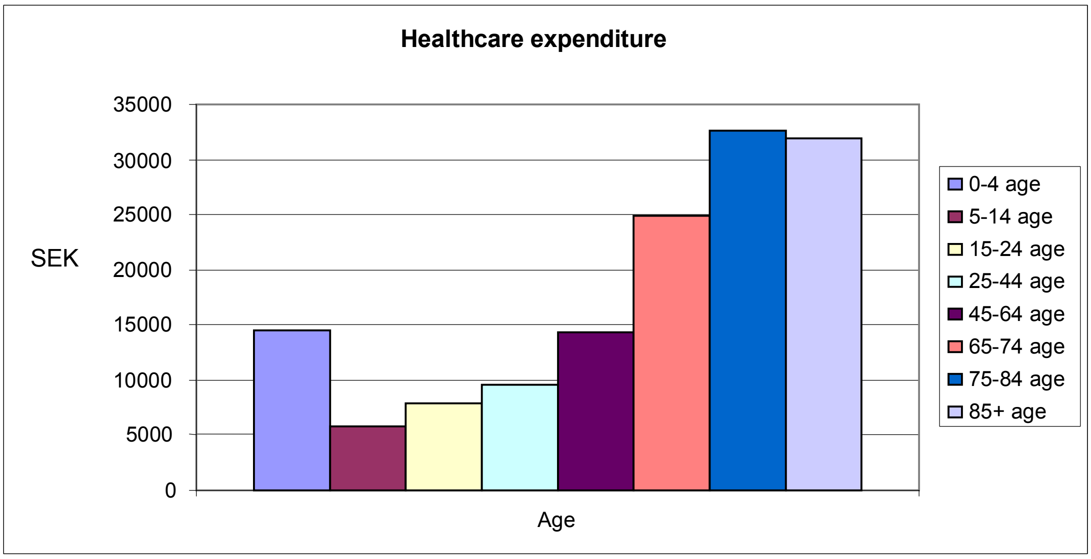

Figure 4. Average costs of healthcare as a function of age in Sweden based on 2005 figures. Source: Region Skåne 2006

Geriatric Care

The cost of geriatric care is included in the model and is governed by the following equation:

$$\frac{dG}{dt} = \alpha G \Rightarrow G = G_0 e^{\alpha t} \delta_G$$

In the equation, G_0 is the average cost of geriatric care which is assumed to increase with economic growth, α. The data is extracted from a report by the Swedish National Board of Health and Welfare (2006b). The report shows that, as expected, the cost of geriatric care increases dramatically with age and this is considered in the model as the costs are set to vary with age according to the data. In the equation, the term δ_G takes the value 1 for age>60 and 0 otherwise. Thus, the equation is only valid afterretirement.

Pension

In the model, three different types of pensions are considered. First, the basic state pension which should be considered as a cost for the government. Secondly, the occupational pension which an individual receives from his/her former employer and lastly, private pension savings. Neither occupational nor private pensions are considered as costs for the government. During retirement, the government receives tax revenue from all three types of pensions as they are all subject to taxation.

The data regarding pensions is extracted from statistics produced by Statistics Sweden (2007e). Pension payments vary depending on age among the pensioners and this is taken into account in the model by varying pensions as a function of age in accordance to the data. Further on, it is assumed that pension benefits increase with the rate of economic growth, α.

$$P = P_S + P_P + P\text{o}$$

$$\frac{dP_S}{dt} = \alpha P_S \Rightarrow P_S = P_{S0} e^{\alpha t} \delta_P$$

$$\frac{dP_P}{dt} = \alpha P_P \Rightarrow P_P = P_{P0} e^{\alpha t} \delta_P$$

$$\frac{dP_o}{dt} = \alpha P_o \Rightarrow P_o = P_{o0} e^{\alpha t} \delta_P$$

Where P_S is state pension, P_P is private pension and P_o is occupational pension.

The term δ_P takes the value 1 for $age > t_P$, and 0 otherwise.

Results

This section presents the results obtained from the model. Figure 6 shows the evolution of the aggregate financial transaction between the individual and the State assuming the set variables.

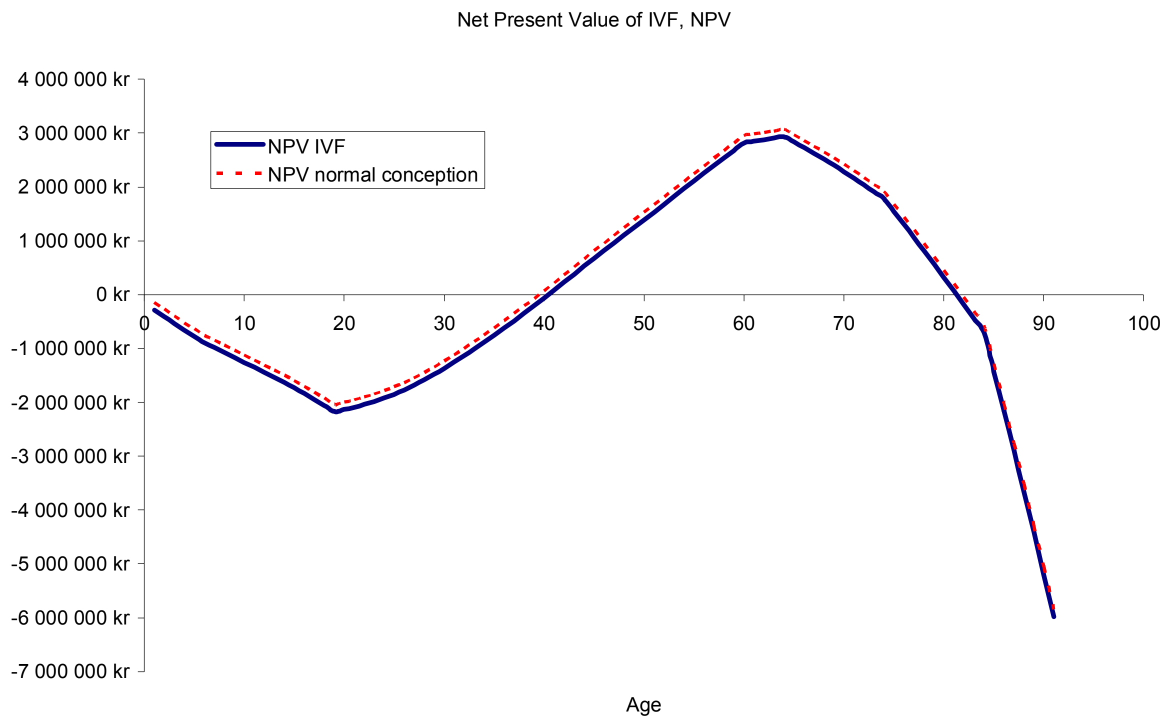

Figure 6.

A positive value indicates a positive return to the State. The diagram indicates that the net return to the State starts in the negative, as it is responsible for the birth costs. In the following education years the net balance gradually decreases further due to health and education expenses. As soon as the individual enters the employment stage, he/she start contributing to the State more than they receive in terms of benefits. During this stage, therefore, the net balance of the State increases gradually, crosses a breakeven point at 41 years of age for an individual born through IVF. The net balance reaches a maximum which coincides with the retirement age. After retirement, government expenditure will increase disproportionably due to costs of state pensions, healthcare and elderly care. If the IVF offspring reaches the average life expectancy of 80 years, the State receives a net return of approximately 254 000 SEK, at present value. At old age, beyond life expectancy, the aggregated costs of a person to the government will outweigh the revenues. This will lead to a second break-even age. This stage stops when the individual dies.

As a comparison, if an individual is conceived naturally, one can calculate the NPV by deducting the costs of IVF since it is the only variable that differentiates the individual conceived through IVF from the normally conceived individual in terms of costs to the government. Hence, the corresponding breakeven age for a naturally conceived individual is 40 years and he/she has returned 459 000 SEK in net present value to the State at the age of 80.

Sensitivity analysis

The model is sensitive to a number of assumptions. A parametric study was carried out to assess the sensitivity of the results to these assumptions. This section presents the findings.

IVF-treatment

First of all, it is important to note that the results are insensitive to the costs of IVF-treatment, as these costs are relatively small compared to the amounts involved in the transaction between the State and the individual during the duration of the individual's lifetime. At a cost of 300 000 SEK the long term fiscal impact is relatively insignificant. Even if the cost associated with IVF-treatment is assumed at as much as 400 000 SEK, the long term effects are rather insubstantial. Breakeven age is increased by two years and at 80 years of age, and the net return to the State decreases to 59 000 SEK. Figure 7 shows the sensitivity of the results assuming different costs of IVF-treatment.

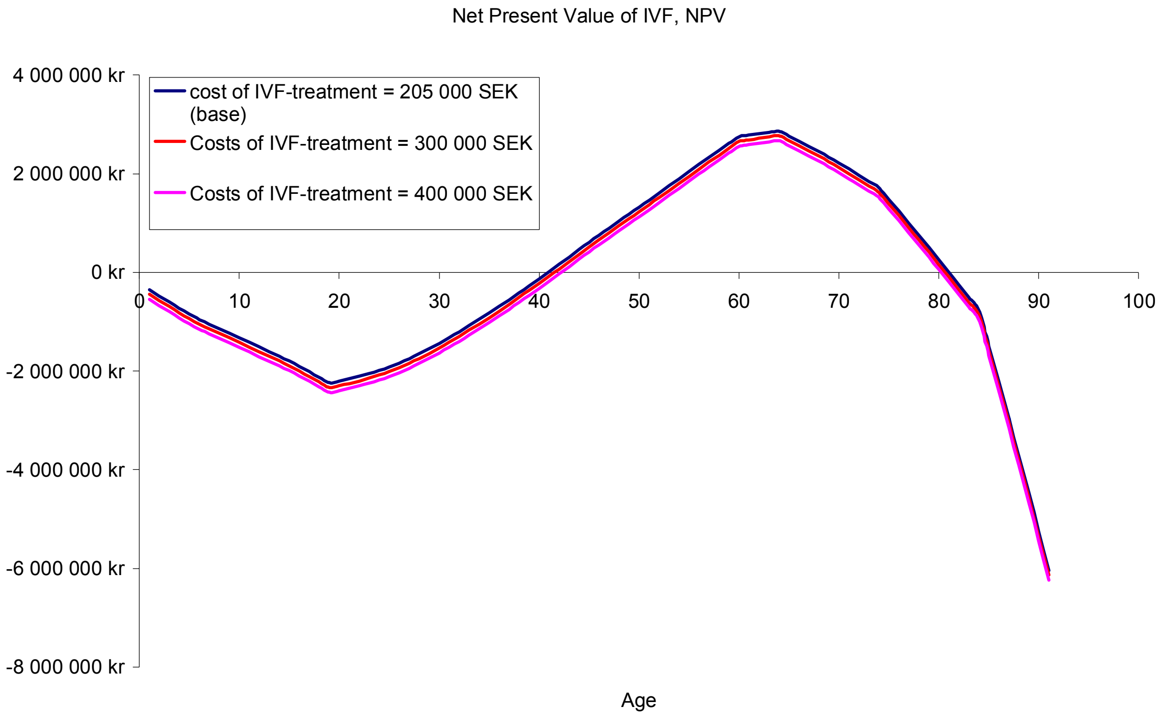

Figure 7. Cost of IVF-treatment.

Life Stages

The life of the individual has been divided in five different stages in the model:

1. Childhood
2. Primary education
3. Secondary/higher education
4. Employment
5. Retirement

The ages at which these stages begin and end are varied in this sensitivity analysis. The model shows a small sensitivity to the age at which primary and secondary/higher education begins. On the other hand, the model is highly sensitive to the age at which employment and retirement begins. Figure 8 and 9 demonstrates how sensitive the model is in terms of age at the start of employment respectively retirement.

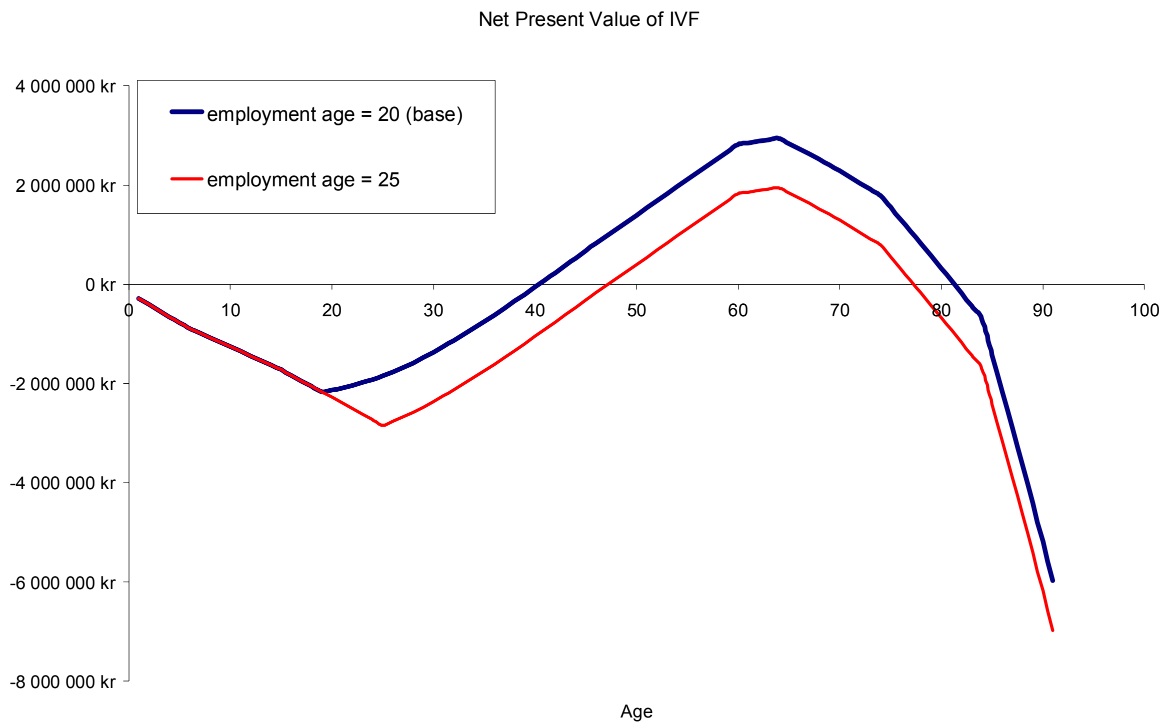

Figure 8. Start of employment.

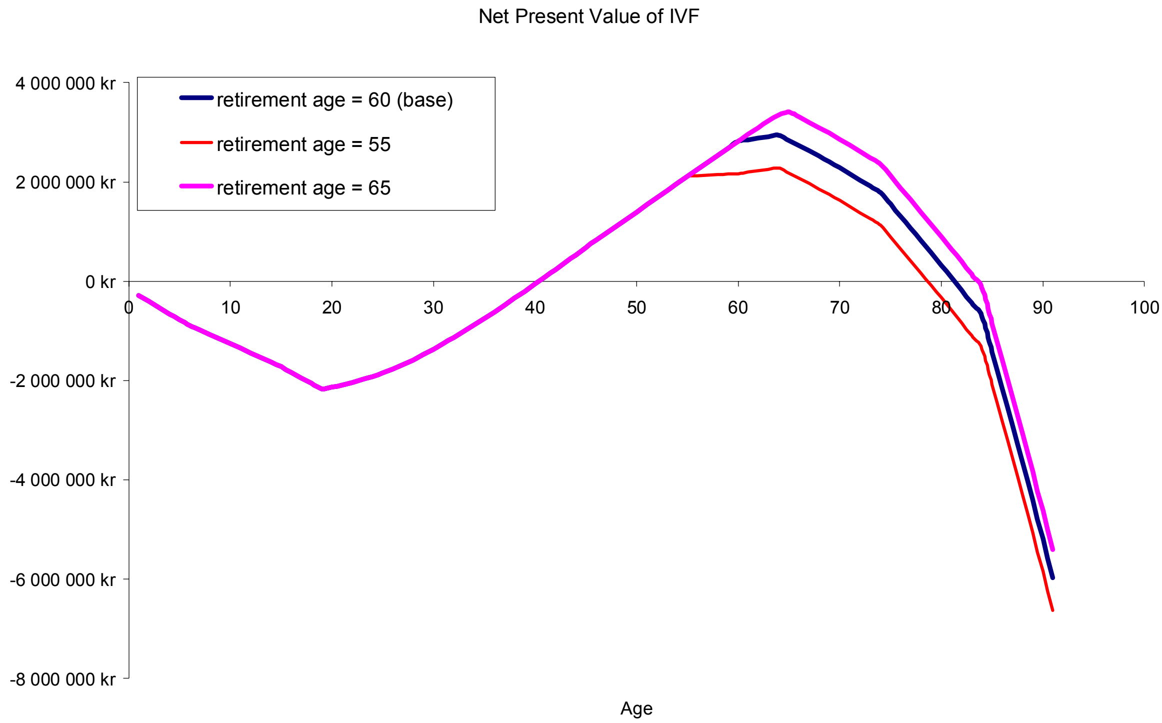

Figure 9.Retirement age.

Financial Variables

The model includes a number of financial variables:

1. Income (tax)
2. Child allowance
3. Costs of education
4. Cost of geriatric care
5. Pension (tax)

The model is insensitive to costs of child allowance and only slightly sensitive to the costs of education and geriatric care. However, as the government revenue is decided by the tax on income and pensions, the model shows a significant sensitivity to the level of taxation. How the NPV varies in accordance to the tax rate is showed in figure ten.

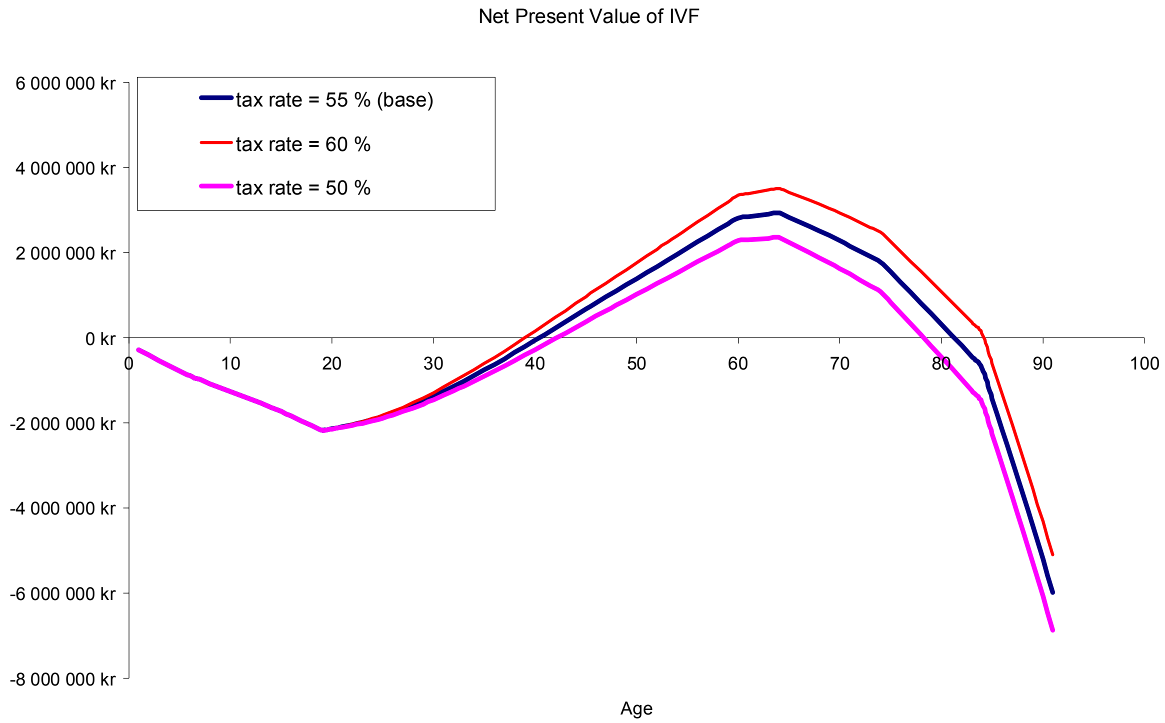

Figure 10. Tax rates.

Rates of change

The model includes a number of parameters that quantify the rate of change in variables. These are:

1. Economic growth
2. Rate of increase in healthcare costs
3. The discount rate

The model was found to be extremely sensitive to these assumptions. An increase in economic growth from the baseline 2.8 percent to 3.8 percent would reduce the breakeven age by three years and increase the net return to the State to 3 140 000 SEK. This is because economic growth would likely result in higher salaries and thus higher tax revenues. On the other hand, an increased discount rate would instead increase the breakeven age and decrease the net return to the State. An increase in the growth of healthcare expenditures becomes important first after the individual terminates the employment stage. This is because the cost of healthcare increases dramatically at older age and consequently an increase in healthcare spending will erode the returns accumulated by the State more rapidly. Diagram 11, 12 and 13 show the sensitivity of the results to economic growth, discount rate and healthcare costs.

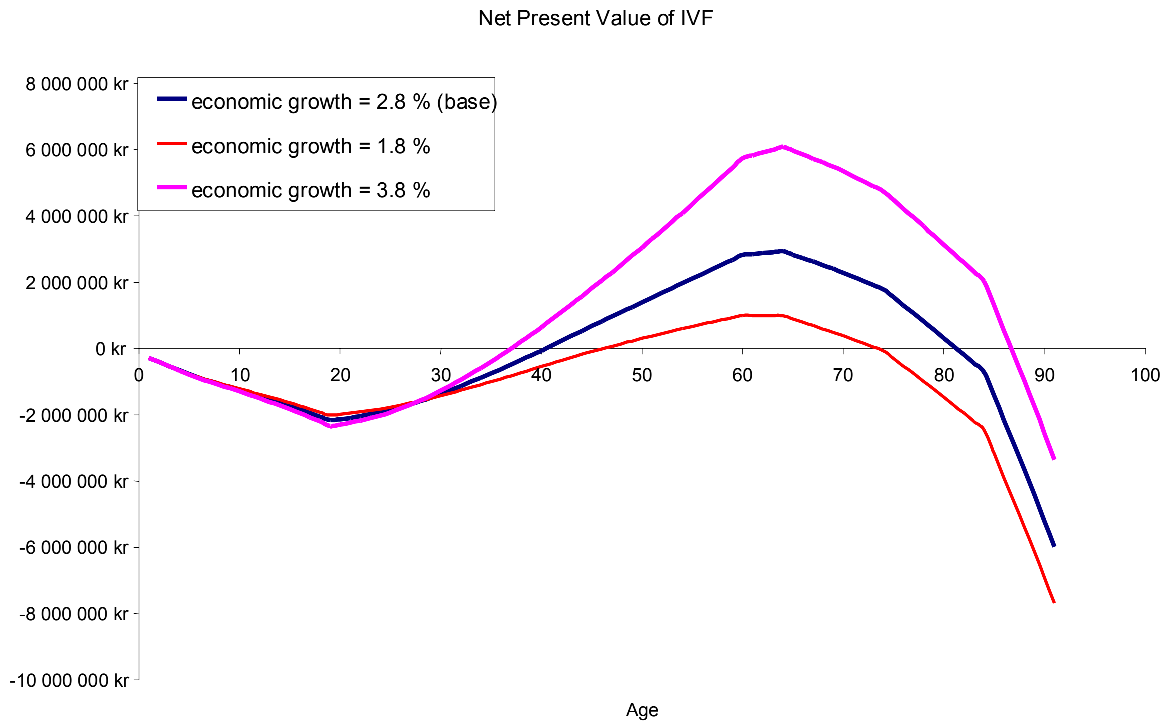

Figure 11. Economic Growth.

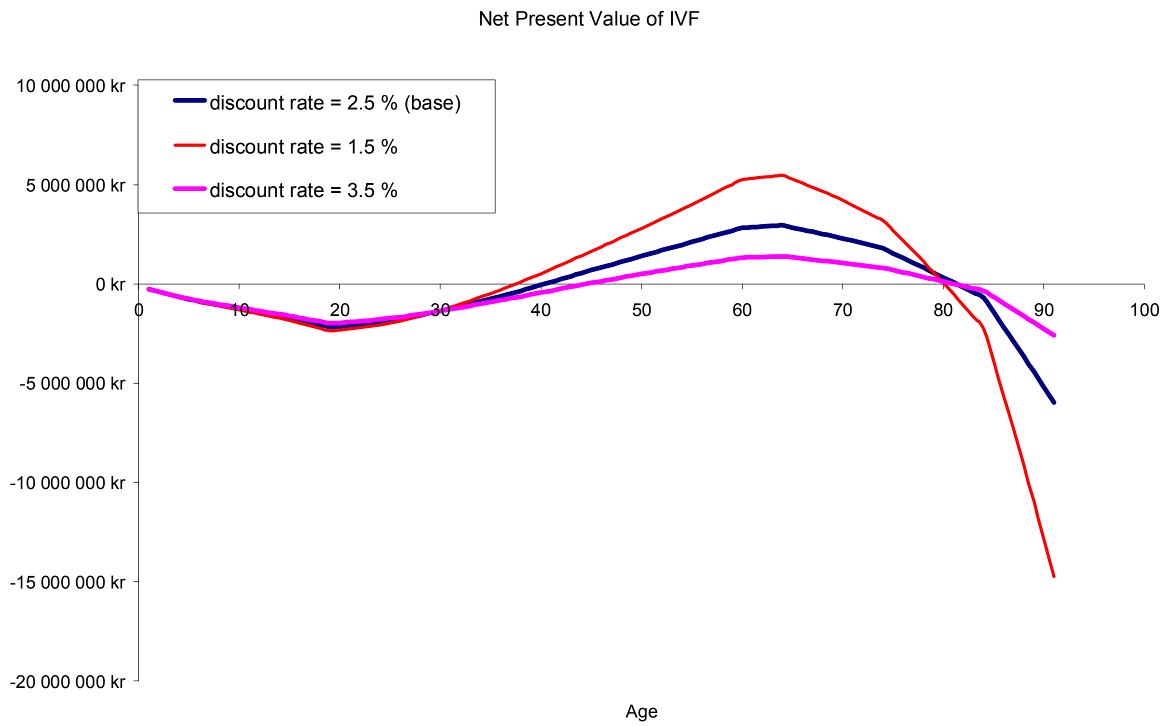

Figure 12. Discount rate.

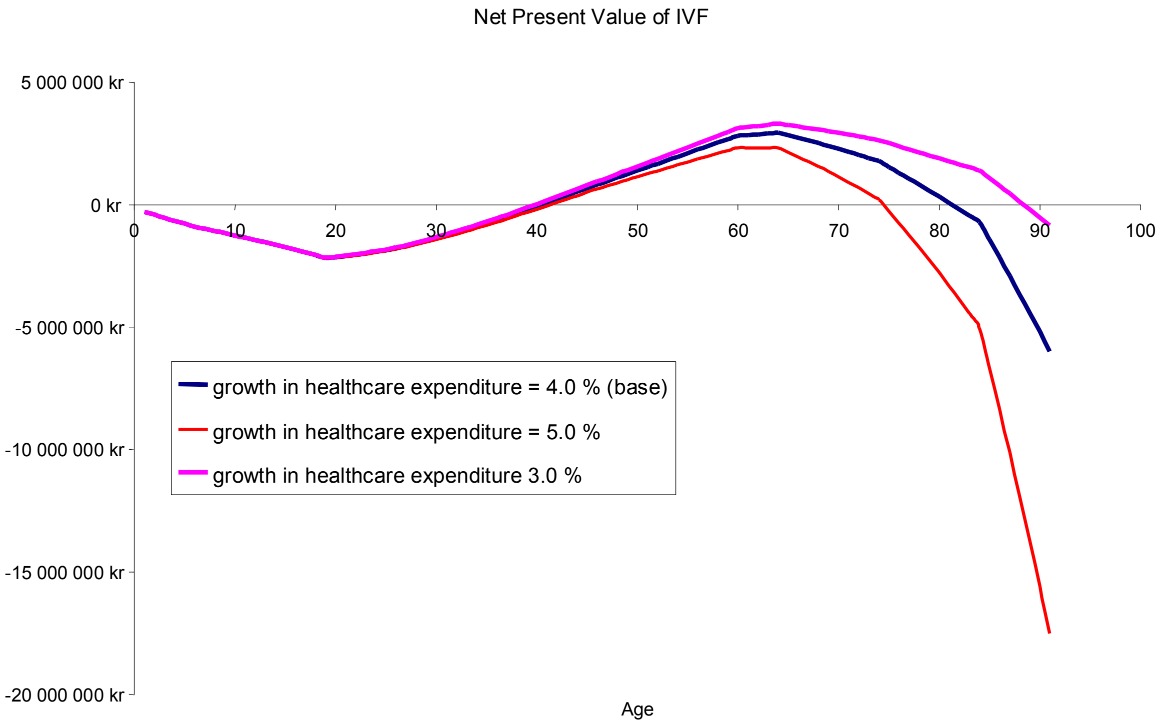

Figure 13. Growth in Healthcare expenditure.

Discussion

The present study’s main objective is to evaluate the long term fiscal impact of State investment in IVF. This is, in one way, also the main limitation of the study since it essentially presents an oversimplified approach to address a complex question: what is the economic value added of demographic growth? IVF can be considered a government subsidy (or investment) for demographic growth and the calculations show (a) the significance of this contribution in the perspective of total costs (e.g. health, education, tax credits) and benefits (tax revenues) and (b) the breakeven point. Wider issues are excluded, e.g.: the net marginal contribution of a child to the economy and society other than government revenues. Hence, normative issues, such as, the right to a child, are excluded.

Another limitation concerns the role of the State. Theoretically, in an economic perspective the State has two roles. One is to transfer funds between individuals and between different time periods during the life of an individual. This is taken into account in the model. The second role is to provide pure public goods and services which cannot, or will not, be produced by the private sector. This is excluded in the model. Implementing the costs of the provision of public goods in the model will, *ceteris paribus*, alter the fiscal impact of an individual born in 2005.

Furthermore, the data do not account for any cohort effects. Using average data for 2005 (in terms of income, pensions, health care costs, etc.) does not consider the consequences of having been born in this year. Unique future pressures, opportunities, challenges or developments of this generation are uncertain and have not been simulated in the model. Also, future changes in epidemiological structure and fertility rates are disregarded in the model. This is an important limitation since both population adjustments and fertility rates will profoundly influence variables such as taxes, health spending and pensions. Additionally, the estimate of the costs of a successful IVF birth is unlikely to be sustained under increased provision. In this model, the future costs of IVF are overestimated. Changes in variables can be taken into account using a real option valuation method which can greatly affect the valuation of potential investments. The NPV valuation method does not include the benefits that real options provide in terms of considering future changes in variables. An 'investment' or 'real option' perspective can be incorporated in subsequent versions of this model, and makes a difference.

The model assumes that there are no asymmetries between IVF births and normal births. This will affect the estimates of costs and benefits of the two target groups to the extent that a newborn child's socio-economic background determines its future in education, labour market, healthcare and life expectancy. For various reasons, it is likely that there are statistical differences between the characteristics (in terms of education, income, social status, etc.) of the two populations of couples who currently undergo IVF treatment and those who do not. These and other characteristics are ignored in the model, and it is therefore relevant to take this into account when interpreting the results of the calculation. In the model, it is also assumed that no discrepancy exist regarding the costs of delivery of IVF-infants as compared to naturally conceived infants. This is an incorrect assumption. As discussed, data indicates that multiple birth and preterm labour is more common among IVF-infants and therefore associated with higher costs of deliverance and neonatal care. However, the rate of multiple birth and preterm labour is decreasing and will likely to continue to do so as the science and research behind IVF is continuously improving. More so, the fact that IVF-mothers generally are older than other mothers may alter the statistics as maternal age is an important risk factor of multiple birth and preterm labour. Hence, the assumption that no difference exist regarding the cost of delivery.

The data regarding income (Statistics Sweden, 2007) includes all individuals at employment age. Consequently, those without a declared income from employment, such as persons on sick-leave and early retirement pensions etc. are included in the statistics. As these individuals do not have an income from employment they will lower the average income for all individuals quite substantially. One could choose to exclude these individuals from the data but as this thesis aims at reflecting the average individual, including those, that for some reason do not work, it is decided to include them in the data. Furthermore, due to the expected changes in population age structure, it is expected that pensions will be subject to considerable reforms in the future. This is however, not taken into account in the model. By using the averages for parameters, the calculation can provide a crude indication of the per capita costs and benefits for the government. However, these distributions for income, pension, health care and education costs (especially for contributions to or withdrawals from public funds) are not uniformly distributed. The use of the expected values of these parameters is potentially problematic when dealing with such skewed distributions.

In the base line model, retirement starts at the age of 60. This is in line with the average Swedish age of retirement which was 60.3 years in 2005 (Swedish Social Insurance Agency, 2006). This can be compared to the official retirement age which is 65 years.

The employment stage is set to commence at the age of 20. Hence, university education is neglected in the model. If university studies were to be included in the model it would increase the age at which employment begins. This would decrease the net return to the state (see figure 8 in the sensitivity analysis). On the other hand, a university degree would most likely lead to higher income during the working stage which in return would generate increased tax revenues to the State. Therefore, the inclusion of university studies would not likely alter the results notably.

The sensitivity analysis shows that the model is highly sensitive to the rate of taxation. In the base line model, it is assumed that income and pensions are subject to a 55 percent tax rate in the form of a 30 percent income tax and a 25 percent VAT. Whether this is an adequate rate of taxation can be discussed as there are several weaknesses in this rather simplistic approach to such a complex matter as how much an individual pays in taxes. First of all, all other taxes that individuals in Sweden can be subject to are excluded, such as capital- and property tax. Secondly, social benefits fees, which are paid by all employers for their employees to cover the employees' health insurance, future pensions etc., are also excluded in the model. If social benefits fees are to be included that would mean that the costs of health care and state pensions are to some degree already paid for by the individual and therefore not a true cost for the State. Thus, the inclusion of social benefits fees would mean that the cost of healthcare and state pensions would be lower for the State. However, as it is difficult to evaluate how much each individual contributes to their own healthcare and state pension in terms of social benefit fees, all such fees are excluded. Thirdly, VAT is a tax added to the price of all of all goods and services. In the model a 25 percent VAT is assumed on all income and pensions. Hence, it is assumed that that all earnings are consumed. This is of course not the case in real life as a proportion of earnings are saved for later consumption. On the other hand, savings are subject to capital tax which is not included in the model. In summary, the model assumes a rather basic method to deal with the tax rate. Which rate of taxation that is the most appropriate can be discussed endlessly and perhaps be developed in subsequent versions of this model. However, the applied tax rate of 55 percent is probably an underestimation as many taxes paid by Swedes are excluded.

When interpreting the results it is important to consider the fact than even though an IVF-offspring will return a net positive value to the State, the offspring has still inflicted a cost to the State in terms of the IVF-treatment, a cost which would not have occurred if the individual would have been conceived naturally. Therefore, subsidized IVF-treatment should only be granted couples that are truly sub-fertile and would not be able to have children without IVF. Subsidizing couples that are able to conceive naturally would instead lead to a loss equivalent to the costs of the treatment. Moreover, the model does not consider behavioural components. Increased reimbursement of IVF could potentially lead to a further postponement of childbirth as expanding the availability of IVF may encourage couples to delay having children as they might assume that IVF will overcome any fertility problem they may encounter. This may counteract the possible gains in fertility rates achieved by subsidized IVF as a woman's fertility starts to drop sharply over the age of 35 even with the help of IVF.

Further on, even tough IVF may help sub-fertile couples it does not cure the problem of infertility. Whether preventing and curing the underlying causes of infertility are more cost-effective than subsidizing IVF-treatment needs to be addressed and evaluated. The methodological approach taken in this thesis could potentially be used to asses other methods of remedying infertility and improving fertility rates.

Conclusion

The model forecasts the lifetime financial interactions between the State and a hypothetical individual born in 2005. The sensitivity analysis showed that the results are sensitive to several parameters. Therefore, the deduced net return to the State should be considered as an approximation as the results will vary significantly depending on the chosen parameters. However, despite the obvious difficulties that lies in predicting future payments during a 80-year long investment one important observation sustains: the costs associated with IVF-treatment are relatively insignificant vis-à-vis other costs and benefits to the government and have a rather small fiscal impact on the State budget in the long run. Hence, subsidizing IVF for sub-fertile couples as a mean to increase fertility rates will not be a burden for the State budget, on the contrary, the IVF-offspring returns a net positive value to the Swedish state. Put differently, the tax revenue generated to the State by the IVF-offspring outweighs what the State pays for services on behalf of the individual. These results suggest that decision-makers should aim at not only looking at the costs of treatment in the short run, but also realise what society can gain from investing in IVF in the long run. In conclusion, the model is not sufficiently sophisticated to provide an adequate forecast of the full economic costs and benefits of subsidizing IVF. For instance, the NPV calculation presented here does not consider the broader socioeconomic value that individuals bring to society. However, the study is sufficient to merit further investigation of the long run economic implications of IVF-treatment such as the likely WTP of the government for increasing TFR. Moreover, the methodological approach in this thesis could possibly be used to asses and compare other interventions and policies currently used in Sweden with the aim of remedying infertility and shaping future, sustainable, population structures.

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Appendix

Data regarding average income as a function of specific ages is not published by Statistics Sweden. However, after mail-correspondence with Statistics Sweden I did received the data via e-mail. As the data is not easily available I have decided to include it as an appendix. See below:

Förvärvsinkomst
2005
Källa: SCB, helårs population

Ålder	Antal			Medelvärde alla		
	Kv	Män	Tot	Kv	Män	Tot
1	48797	51737	100 534	19	27	23
2	48562	51169	99 731	37	30	33
3	47462	49623	97 085	63	47	55
4	45240	47788	93 028	71	83	77
5	44893	47637	92 530	97	94	96
6	44242	46377	90 619	108	124	116
7	44417	47246	91 663	153	145	149
8	45135	47565	92 700	197	180	188
9	47676	49701	97 377	220	223	222
10	51200	54117	105 317	280	277	279
11	55913	58287	114 200	343	336	339
12	58389	60942	119 331	423	388	405
13	60918	64397	125 315	536	530	533
14	62132	65959	128 091	811	856	834
15	63052	66401	129 453	1 500	1 730	1 618
16	59542	62958	122 500	3 624	3 828	3 729
17	57949	61617	119 566	7 653	7 369	7 507
18	55193	57546	112 739	15 411	14 240	14 813
19	53669	56933	110 602	40 180	39 761	39 964
20	52156	55336	107 492	73 734	77 983	75 921
21	50161	53040	103 201	84 767	107 323	96 359
22	49475	51819	101 294	90 129	122 383	106 629
23	50187	52504	102 691	96 711	131 861	114 683
24	50984	52720	103 704	109 449	145 048	127 546
25	52619	54634	107 253	125 111	160 427	143 101
26	52219	53877	106 096	142 444	177 450	160 221
27	50978	52601	103 579	156 654	196 615	176 948
28	52085	54228	106 313	169 157	211 568	190 790
29	53562	55592	109 154	176 366	226 782	202 043
30	56306	58293	114 599	181 195	240 745	211 486
31	59274	61382	120 656	185 995	252 457	219 807
32	59124	60961	120 085	189 686	262 360	226 579
33	60330	62182	122 512	192 553	270 238	231 983
34	60795	62937	123 732	196 734	278 107	238 125
35	59396	60926	120 322	199 442	282 576	241 537
36	58649	60841	119 490	203 803	289 703	247 541
37	61732	63658	125 390	207 406	293 522	251 126
38	64812	67975	132 787	212 212	299 939	257 120

39	65565	68771	134 336	216 467	301 791	260 147
40	65852	69082	134 934	219 642	305 329	263 511
41	66249	68801	135 050	222 837	306 807	265 615
42	61245	64473	125 718	225 830	309 709	268 846
43	58828	61139	119 967	225 970	308 429	267 994
44	57214	59296	116 510	230 007	311 590	271 528
45	56811	58214	115 025	228 855	310 244	270 046
46	57029	59164	116 193	231 907	312 316	272 850
47	57005	58851	115 856	234 428	312 248	273 958
48	58247	59129	117 376	235 327	312 894	274 402
49	57854	60035	117 889	236 620	310 633	274 311
50	57643	58583	116 226	238 120	311 497	275 105
51	56408	57451	113 859	236 318	311 191	274 097
52	57651	59016	116 667	237 074	312 321	275 138
53	57474	58280	115 754	235 477	312 234	274 123
54	57038	57654	114 692	235 606	310 023	273 014
55	59152	60198	119 350	234 252	313 367	274 156
56	61640	61967	123 607	234 799	313 986	274 497
57	63778	63883	127 661	232 466	313 277	272 905
58	64173	64434	128 607	229 424	309 056	269 321
59	64631	65287	129 918	226 543	308 121	267 538
60	63599	64684	128 283	226 592	310 601	268 952
61	62243	63499	125 742	222 145	306 594	264 791
62	58388	58760	117 148	217 670	304 053	260 999
63	52986	53826	106 812	211 374	292 936	252 476
64	47237	46953	94 190	199 291	276 659	237 858
65	44758	44390	89 148	187 614	272 636	229 950
66	45171	43878	89 049	171 173	258 115	214 013
67	43331	41289	84 620	164 366	250 210	206 252
68	41124	38779	79 903	159 598	242 646	199 903
69	40095	36810	76 905	155 661	236 245	194 232
70	37754	34794	72 548	147 912	222 294	183 585
71	37054	32796	69 850	140 598	208 773	172 607
72	35997	31387	67 384	139 491	205 088	170 046
73	37172	31591	68 763	136 647	201 625	166 499
74	36701	30486	67 187	135 534	198 366	164 044
75	37050	29749	66 799	132 797	194 011	160 059
76	35343	27956	63 299	131 314	189 863	157 172
77	35863	27579	63 442	129 850	187 718	155 006
78	34116	25582	59 698	130 010	185 339	153 719
79	33840	24675	58 515	128 429	183 080	151 475
80	33433	23760	57 193	127 185	183 441	150 556
81	32358	22065	54 423	125 598	180 858	148 002
82	30954	21013	51 967	124 593	178 814	146 517
83	29365	18582	47 947	123 847	176 675	144 321
84	29642	17933	47 575	123 761	179 236	144 672
85	28562	16485	45 047	123 606	177 926	143 485
86	21387	11876	33 263	123 359	176 818	142 446
87	18947	9902	28 849	123 729	178 807	142 634
88	17112	8283	25 395	120 325	176 290	138 579
89	14539	6719	21 258	117 829	175 031	135 909
90	12200	5122	17 322	116 884	170 759	132 814
91	10422	4250	14 672	114 216	167 277	129 586
92	8475	3242	11 717	112 456	162 756	126 374
93	6820	2275	9 095	110 926	153 166	121 492
94	5096	1592	6 688	107 748	157 695	119 637
95	3750	1110	4 860	106 398	146 309	115 513
96	2760	760	3 520	103 922	135 540	110 748

97	1895	450	2 345	103 039	130 622	108 332
98	1221	298	1 519	104 286	130 470	109 423
99	801	165	966	102 352	129 247	106 946
100	492	91	583	98 091	111 661	100 209
101	271	39	310	100 602	123 956	103 540
102	176	34	210	93 961	94 354	94 024
103	87	27	114	88 074	82 864	86 840
104	56	9	65	91 663	120 328	95 632
105	34	2	36	74 490	184 363	80 594
106	9	2	11	82 796	42 972	75 555
107	9	1	10	83 686	0	75 317
108	1	0	1	0	0	0
109	0	0	0	0	0	0
110	2	0	2	85 944	0	85 944
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