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## ARTICLE

# Costs and benefits of individuals conceived after IVF: a net tax evaluation in The Netherlands




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**Abstract** This study evaluated the lifetime future net tax revenues from individuals conceived after IVF relative to those naturally conceived. A model based on the method of generational accounting was developed to evaluate investments in IVF. Calculations were based on average investments paid and received from the government by an individual. All costs were discounted to their net present values and adjusted for survival. The lifetime net present value of IVF-conceived individuals was –€81,374 (the minus sign reflecting negative net present value). The lifetime net present value of IVF-conceived men and women were –€47,091 and –€123,177, respectively. The lifetime net present value of naturally conceived individuals was –€70,392; respective amounts for men and women were –€36,109 and –€112,195. The model was most sensitive to changes in the growth of healthcare costs, economic growth and the discount rate. Therefore, it is concluded that, similarly to naturally conceived individuals in the Netherlands, IVF-conceived individuals have negative discounted net tax revenue at the end of life. The analytic framework described here undervalues the incremental value of an additional birth because it only considers the fiscal consequences of life and does not take into consideration broader macroeconomic benefits. 

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**KEYWORDS:** economics, generational accounting, health investments, in vitro fertilization (IVF), live birth, net present value

## Introduction

The baby boom after the Second World War and the introduction of birth control in the late 1960s has caused a demographic shift in the Netherlands (van der Horst et al., 2010). The combination of ageing baby boomers and declining birth rates may well result in healthcare expenditure that is unsustainable for future generations (van der Horst et al., 2010).

Currently in the Netherlands, healthcare expenditure is 9.8% of the gross domestic product (GDP), and rising each year (Roehr, 2010). This expenditure pattern is comparable to other European countries (e.g. UK 9.0% GDP and Germany 10.4% GDP; World Health Organization, 2011).

IVF sometimes seen by politicians, policy makers and the general public as a medical luxury product and therefore prone for healthcare cuts. In 2009, one out of 38 individuals born in the Netherlands was a result of IVF (NVOG, 2010). If IVF is cut from public financing, a percentage of these individuals will not be born, because many couples are unable to pay for IVF themselves.

In the short term, cutting costly IVF treatment from the government's expenditure is cost minimizing, but this is questionable on the long term. The birth of IVF individuals will, apart from fulfilling a wish for a child for a couple, lead to tax revenues in the future, as these children will mostly become economically active adults in society. A calculation of lifetime tax revenues of IVF-conceived individuals in the UK, USA and Sweden showed positive tax revenues attributed to investments in IVF, suggesting that IVF is a good use of public resources (Connolly et al., 2009, 2008; Svensson et al., 2008).

These calculations were made by the method of generational accounting. Generational accounting is used to calculate the fiscal burden facing currently living generations on the basis of current fiscal rules and extrapolating it into net taxes of the future. Net taxes are calculated by subtracting the taxes minus the transfers. Transfers include expenditures on health, education, individual benefits, pensions and taxes include income tax and value added taxes (Bovenberg and ter Rele, 2000; Kotlikoff, 1992). In principal, generational accounting considers whether there will be sufficient tax revenue collected in the future to pay for government programmes, whether tax increases or other policy adjustments are necessary to cover government expenditure in the future and whether the tax burden is evenly distributed over generations or whether costs are simply passed onto future generations.

Previous studies showed that IVF represents a positive net tax revenue for the government, but social security transfers and tax rates differ across countries. Therefore, this work assessed the long-term economic benefits attributed to IVF-conceived individuals in the Netherlands. Furthermore, this work extends the previous analytic framework by considering differences in net tax revenue that may arise following the birth of an IVF-conceived boy or girl.

## Materials and methods

A generational accounting model was built to estimate financial transactions between IVF-conceived singletons

and the Dutch government over their projected lifetime (Cardarelli et al., 2011). Average IVF costs to achieve a live birth are treated as an investment in human capital with long-term economic consequences. In current work assumes the individuals to be average in terms of education, earnings and health, and also that IVF-conceived individuals are the same as naturally conceived individuals. The base case year was set at 2008. All monetary units were converted into the equivalent of 2008 using the consumer price index (Statistics The Netherlands, 2011b). If available numbers were categorized, they were intrapolated. (The given number was assumed to be the average of the given category. A linear equation between two subsequent categories was made with the following form:  $y = ax + b$ , where  $a$  is the slope of the line and  $b$  is the intercept with the  $y$ -axis.  $a$  could be determined by dividing  $\Delta y$  by  $\Delta x$ . Now  $b$  could be determined by using a known point in the equation.)

The life course considered in the model included the following five states: early childhood, primary education, higher education, employment and retirement. During the three stages of early childhood and education, the individual mainly receives investments from the government. When the individual enters employment, the government becomes a net recipient of taxes. Subsequent to employment, the individuals retire and tax contributions reduce, but health and pension benefits will be provided until the end of life.

## Quantification of the net tax contributions

Applying the generational accounting framework, the net tax contribution or net tax deficit for an individual at any stage of life can be derived using the following equation:  $N_t = T_t - E_t - H_t - C_t - PS$ , where  $T_t$  is tax revenue paid to the government,  $E_t$  and  $H_t$  are the education and healthcare costs,  $C_t$  are the individual tax credits (e.g. mortgage benefits) and  $PS$  is the government pension. The individual also draws a private pension of which the government receives a percentage through taxation. The net tax contribution at any point in time is represented by  $NT_t$ .

The model for each stage depends on the functional forms for mean income, taxes, education costs and health care, as well as individual tax credits. The direct costs at each stage are based on average transfer costs and adjusted for the proportion of people at each stage over the defined period as follows: (i) childhood prior to education: from birth to year  $t_E$ ; (ii) primary/secondary education: from year  $t_E$  to year  $t_C$ ; (iii) secondary/tertiary education: from year  $t_C$  to employment,  $t_e$ ; (iv) employment: from year  $t_C$  or  $t_e$  to pension,  $t_p$ ; and (v) retirement: from  $t_p$  until death,  $t_D$ .

In the health investment model, the following values were assigned for each of the constants described above:  $t_E = 6$ ,  $t_C = 16$ ,  $t_e = 29$ ,  $t_p = 65$ ,  $t_D = 100$ . A survival curve of the average population was applied to the model to represent an average individual, male and female (Statistics The Netherlands, 2011d): for example, at the age of 20 years, 99% of the population is alive and at the age of 60, 88%. Retirement age was set at 65, which is current policy in the Netherlands. Stages III and IV overlap, because between the ages of 16 and 29, a proportion of people

attend secondary/tertiary education and a proportion attends employment (Organisation for Economic Co-operation and Development, 2011). All cost calculations were made on an average individual and for an average male and female. For an overview of all revenues and expenditures, see Table 1.

## Sources

To derive all transfers from the government to an individual, various sources were used. The National Institute for Public Health and the Environment (RIVM) provided age-specific information on healthcare costs. Statistics Netherlands has a public database, containing data on various subjects including age-specific data on income, income components, inflation, number of households, education level and household expenses. The Netherlands Bureau for Economic Policy Analysis provided information concerning economic parameters like the economic growth and growth in healthcare expenses. Other searched data sources were the Ministry of Finance, the Ministry of Education, Culture and Science, the Ministry of Healthcare, Welfare and Sport and the Social Insurance Bank.

## Labour productivity growth

To account for economic growth over time, costs were adjusted according to economic growth (Auerbach et al., 1999; Cardarelli et al., 2011). Average economic growth was set at 1.7% according to the Netherlands Bureau for Economic Policy Analysis (CPB Netherlands Bureau for Economic Policy Analysis, 2011). All costs were adjusted for labour productivity growth (Statistics the Netherlands, 2011b).

## Transfers from the government to individuals

### Healthcare costs

IVF cost was based on the Dutch umbrella study (ZONMW, 2005). An average success rate of 28% per cycle, which reflects the success rate of a 30-year-old women, was used to calculate the cost per live birth (Lintsen et al., 2007). The cost per singleton live birth was €10,982 adjusted for inflation (Statistics the Netherlands, 2011b). The current

calculations were based on an IVF-conceived singleton child, because the current trend is to try to reduce multiple pregnancies by applying single-embryo transfers. In the Netherlands, this has resulted in a significant reduction of multiple pregnancies without a decline in pregnancy rate (NVOG, 2010).

Delivery costs were not included in the model, since these costs are assumed to be similar between IVF and non-IVF individuals.

Healthcare spending in the Netherlands accounts for 9.8% of gross domestic product (Roehr, 2010). The age-and-sex-specific costs per capita expenditure was used in this model. Healthcare costs paid by the health insurance companies and other financiers than the government were excluded (National Institute for public health and the environment, 2008). The model assumed an annual increase in age-adjusted health expenditure according to labour productivity growth.

### Individual-related transfers

**Education.** Education costs are based on individuals attending government-funded schools. The assumption was made that all individuals will attend government-funded education, which is mainly the case in the Netherlands. All individuals are assumed to attend school from the age of 4 to 16 years of age, as obliged by the Dutch law. The costs for primary education were €5300 and €7107 for secondary education (Organisation for Economic Co-operation and Development, 2011). After the age of 16, education remains funded by the government. According to the distribution provided by the Dutch statistics, after the age of 16, a proportion of people start employment and a proportion stays attending education until the age of 29 (Organisation for Economic Co-operation and Development, 2011). The average cost for tertiary education was €6134. Average education costs were calculated per year according to age, sex and level of education distributions.

**Education allowance.** Education cost benefit is available for individuals younger than 18 years who already participate in tertiary education. This allowance is dependent on the income of the parents. The per capita cost of €707 was adjusted for the proportion of students receiving the allowance (Informatie Beheer Groep, 2009).

**Financing of tertiary education.** All students from 18 to 30 years receive student financing if they attend tertiary education. This finance is irrespective of the income of the parents. Depending on the parent's income, some students qualify for a supplementary grant. Calculated average costs per student per year were €6130 (Informatie Beheer Groep, 2009). Average costs were adjusted according to the participation rate in tertiary education (Organisation for Economic Co-operation and Development, 2011).

**Child benefit.** Child benefit is part of the social security system in the Netherlands. It is known as the General Individual Benefit Act (Algemene Kinderbijslag Wet). All parents receive child benefit until the 18th birthday of their child (Sociale verzekeringsbank, 2010). The amount of benefit is age dependent. Children below 5 years receive €774.92 per year, children aged 6–11 €940.96 per year and children

**Table 1** Overview of government revenues and expenditures.

Revenue	Expenditure
Income tax and duties	Healthcare costs
Value-added tax	Education costs
	Child benefit
	Child-bound-budget
	Daycare contribution
	Pension
	Unemployment benefit
	Welfare support

aged 12–18 €1107.00 per year ([Sociale verzekeringsbank, 2010](#)).

*Child-bound budget.* The child-bound budget is a budget available for children aged below 18 years. This budget is income dependent, therefore only parents who have a low income are eligible for these benefits. This work calculated the average benefit, which was €106 per household ([Statistics the Netherlands, 2010a](#)).

*Daycare contribution.* In the Netherlands, working parents are eligible for daycare contributions according to their income. According to the total costs of paid premium and the total amount of households and the percentage of households that are eligible for this premium, average cost per year could be calculated. Average costs for children aged 0–4 were €3381 and for children aged 4–12 years €1207 ([Dutch Government, 2011](#)).

*Adult-related transfers.* Average age- and sex-stratified income was obtained from the Statistics the Netherlands, the Netherlands has a publicly available database with its costs and transfers ([Statistics the Netherlands, 2011a](#)). Income was based on single households, to ensure that all income components could be ascribed to one individual. Income components in the database were subdivided by primary income, gross income and disposable income ([Statistics the Netherlands, 2011a](#)). According to these tables, all average transfers from the government to an individual during adult life could be calculated. These transfers include, amongst others, pensions, unemployment benefits and welfare support.

## Transfers from the individual to the government

### Income tax and duties

To calculate the income tax and duties, the stratified income tables as ascribed above were used ([Statistics the Netherlands, 2011a](#)). By extracting the gross income minus the primary income and transfers like alimony and private income insurance (which are included in the gross income provided by Statistics the Netherlands), the transfers (income tax and duties) to the government could be calculated stratified by sex and age ([Statistics the Netherlands, 2011a](#)).

### Value-added tax

Based on the disposable income, the government's income by Value-added tax (VAT) was calculated. This work assumed that the whole disposable income would be spent ([Statistics the Netherlands, 2011a](#)). Two VAT rates are used in the Netherlands, a low rate of 6% on food/provisions and a high rate of 19% on all other goods and services. No VAT has to be paid on services like health care and education ([European Commission, 2010](#)). In 2008, households spent 33% on fixed costs (including 2% consumption taxes), 15.6% on food/provisions, 2.3% on health care and 3% on other expenses (donations, contributions). This leaves 46.1% for other goods and services ([Statistics the Netherlands, 2010b,d](#)).

## Discount rate

To reflect the depreciation of money over time, this work applied a discount rate on the costs of IVF (2008). This calculation method is also referred to as net present value. Valuing future costs and benefits in discounted terms is the primary criterion for establishing whether government action on programmes can be justified (HM Treasury, 2003). A 4.0% discount rate was applied to all costs ([Health care insurance board, 2006](#)).

## Sensitivity analysis

A sensitivity analysis tested the uncertainty of the model: one-way deterministic sensitivity analysis was performed and tornado diagrams were used to present the results. The ranges in which the model was tested were changed within a 75–125% interval for absolute costs, due to great uncertainty, wide ranges were used. Economic growth rates and healthcare growth were changed between 0–5%. The discount rates were changed between 1–7%. Also a threshold analysis was performed.

No ethical approval for this research was needed. All calculations were made in Office Excel (Microsoft, 2003).

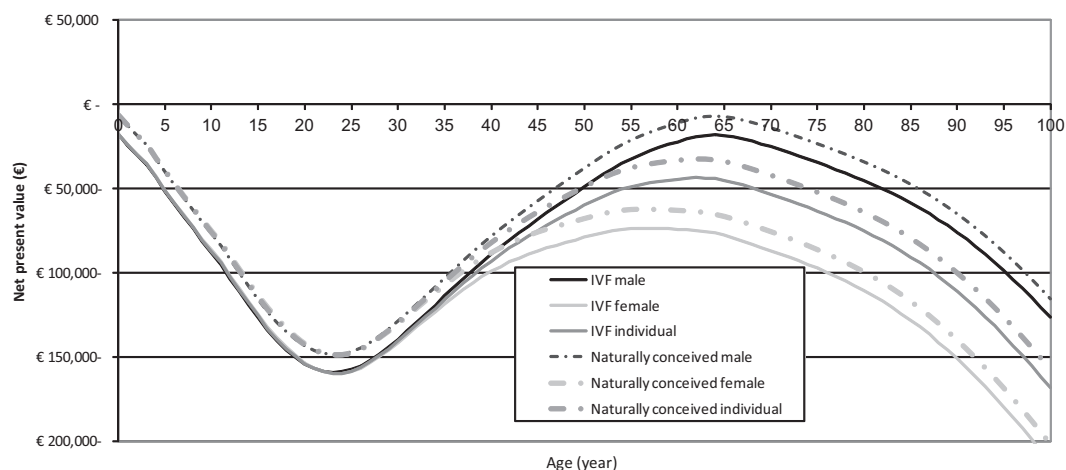
## Results

The projected lifetime net present value of IVF-conceived individuals, both male and female, are illustrated in [Figure 1](#). A positive value at any time represents a return to the government, while a negative value represents an investment of the government. For an average IVF-conceived individual, the net present value is negative during his/her entire life. The same pattern is seen for men and women who stay a net investment of the government. Also the net present value of IVF-conceived and naturally conceived individuals follows a similar fiscal life course whereby the only difference between the two is the additional IVF investment that is required for conception.

The discounted lifetime net present value of an IVF-conceived average individual was –€81,374: –€47,091 for an IVF-conceived average man and –€123,177 for an IVF-conceived average woman. The undiscounted lifetime net present value was –€477,502, for an individual: –€12,241 for a man and –€993,059 for a woman. The discounted net present value at the age of 25, 50 and 100 years of IVF-conceived and naturally conceived individual are shown in [Table 2](#).

## Sensitivity analysis

This work evaluated the robustness of the model by one-way sensitivity analysis. Calculations were made for an average individual. The results are presented in a tornado diagram. A tornado diagram indicates the effect of cost changes due to changes in the parameters within the set ranges. Each parameter is listed next to its range ([Figure 2](#)). The parameters of healthcare growth, discount rate and economic growth were most sensitive for changes within the set

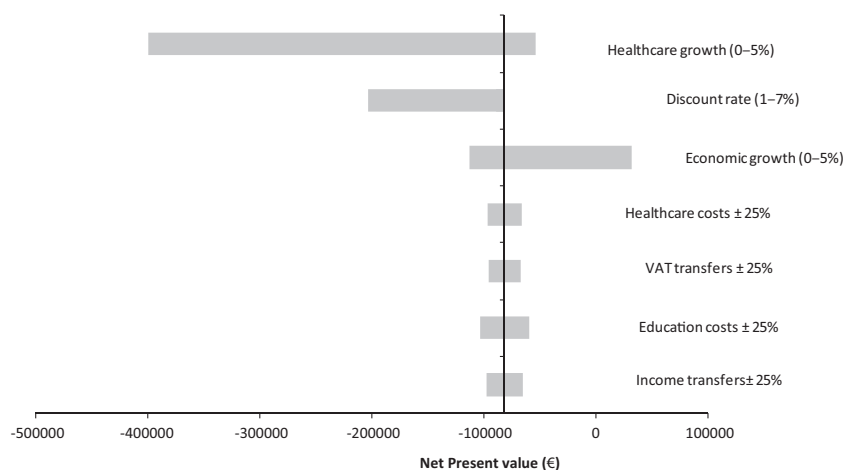


**Figure 1** Net present value for an IVF and naturally conceived individual, female and male. The curves are not adjusted for survival. For example, if a naturally conceived man dies at the age of 65, his net present value equals –€7372.

**Table 2** Net present value undiscounted at different age points in life and discounted (average life).

	25 years (€)	50 years (€)	100 years (€)	Adjusted average life (€) <sup>a</sup>
Individual				
IVF	–147,303	–48,839	–157,164	–81,374
Naturally conceived	–158,285	–59,820	–168,146	–70,392
Male				
IVF	–146,397	–37,786	–115,099	–47,091
Naturally conceived	–157,379	–48,768	–126,081	–36,109
Female				
IVF	–147,727	–67,812	–201,810	–123,177
Naturally conceived	–158,709	–78,794	–212,791	–112,195

<sup>a</sup>Adjusted for survival.



**Figure 2** Tornado diagram indicating the effect of cost changes due to changes in the parameters within the set ranges. Each parameter is listed next to its range.



ranges. Transfers based on income and education costs had the lowest influence. Threshold analysis showed that if absolute education costs declined by more than 94%, the net present value would be positive at the end of life. Also if transfers based on income increased by more than 228%, transfers based on VAT increased by more than 244% and economic growth would be more than 4.1% per year, the NPV would be positive at the end of life for an average individual. For discount rate, healthcare costs and growth, no threshold could be found where the NPV became positive at the end of life.

## Discussion

According to this analysis, the net present value at the end of life of IVF-conceived individuals is negative, for both men and women. The same is true for naturally conceived individuals in the Netherlands.

The results described here are consistent with a generational accounting analysis conducted in 1995 for the Netherlands to estimate future intergenerational transfers which showed a similar trend, but with a smaller negative return at the end of life, namely  $-\$76,000$  (index level 2008,  $-\text{€}52,456$ ; Bovenberg et al., 1999). The discrepancy between the two calculations can be explained by different factors. First, the current calculation is based on an average individual from a single household, while the previous study was based on the whole population with a distribution of different households. This work used the single household to be certain that income could only be ascribed to one person and assumed that households consisting of more than one individual are more successful and therefore have a higher income and consequently pay more taxes. Secondly, the current model applied different rates for healthcare growth, economic growth and discounting, which are more valid now compared with 17 years ago. Finally, government policy on taxes and investments and the population distribution have changed considerably since 1995 (Statistics the Netherlands, 2011c).

Net present value calculations in the USA, Sweden and UK have previously described a positive result at the end of life. Calculations in the USA showed a positive net return of 700% of the initial investment (Connolly et al., 2008). Sweden showed a similar pattern as the Netherlands, but in contrast their calculated return was positive at the end of life (Svensson et al., 2008). Calculation in the UK showed a positive return of 850% of the initial investment to the government (Connolly et al., 2009). Differences can be explained by differences in taxing, social benefits and labour participation. Therefore, the current work's outcome cannot be extrapolated to other countries.

This is the first analysis that differentiates between men and women. Both men and women had a negative return at the end of life, but the negative return of women ( $-\text{€}123,177$ ) was much higher compared with that of men ( $-\text{€}47,091$ ). This can partly be explained by the lower labour participation of women compared with men. In 2008 59.2% of all women were working, against 77.1% of all men

aged 15 years and older (Statistics the Netherlands, 2010c). Also, if women work, this is more likely to be part-time compared with men and the income of women is still lower than that of men, resulting in less income tax and VAT (Statistics the Netherlands, 2011a).

Another explanation for the difference between men and women are the healthcare costs. During working life, the costs are approximately the same, but from retirement to the end of life, women consume more health care. This is probably because women live longer than men and as age progresses, healthcare costs increase more rapidly (National Institute for public health and the environment, 2008).

The method of generational accounting has many advantages: for example, it focuses on the policy effect on future generations and also takes future developments into account. These properties mean that generational accounting is suitable to test the sustainability of policies. One of the greatest weaknesses of generational accounting is that it has to rely on specific assumptions. Because these assumptions are applied over generations, the margin of error can become relatively large. It also does not take changes in policies into account that one cannot foresee at the moment of calculation (e.g. potential future changes in taxes). The results thus have to be interpreted with caution.

This analysis showed a negative return at the end of life, for an average IVF individual, for both men and women. Because an IVF individual does not result in a positive return, the government could decide not to invest in IVF, but on the other hand, naturally conceived individuals also give a negative return at the end of life. When only the cost per live birth is taken into account irrespective of the cost transferred and gained in the rest of its life, the costs per life gained are  $\text{€}10,982$  for a 30-year-old mother. This is below the cost per life years gained threshold in the Netherlands, namely  $\text{€}20,000$  per life year gained (Zwart-van Rijkom et al., 2000). Apart from that, the wish for a child of an infertile couple is fulfilled, thus increasing quality of life of the parents. Another reason why IVF should be supported by the health system is the effect of multiple gestations caused by IVF. Insurance coverage for IVF services seems to be associated with a decreasing number of embryos transferred which consequently has an effect on multiple gestations (Reynolds et al., 2003). Multiple gestations are associated with high costs, therefore society benefits from IVF covered by collective funding (Lukassen et al., 2004). In Belgium, IVF-related laboratory costs were reimbursed only when a transfer policy based on single-embryo transfer was applied. As a result of this project, IVF cycles increased by more than 30% and a more than 50% reduction of twin pregnancies was observed (Ombelet, 2007). Reducing the healthcare costs caused by neonatal costs linked to multiple pregnancies would save 85% of the IVF budget (Ombelet, 2007).

In summary, all individuals in the Netherlands have a negative lifetime discounted net tax revenue from the perspective of government at the end of life, but individuals conceived after IVF reach this point earlier in life. Whether this is an argument not to reimburse IVF anymore depends

on the views of society at large and the returns from other social and health policies receiving public funds. Because the framework described here translates investments in health programmes into discounted net tax revenue for government, the approach can conceptually be used to compare a wide range of government investments such as education, infrastructure or defence.

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