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Costs and Benefits of Individuals Conceived after IVF: A Net Tax Evaluation in the Netherlands

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Abstract

We evaluated the lifetime future net tax revenues from individuals conceived after in vitro fertilisation (IVF) relative to those naturally conceived. We developed a model based on the method of generational accounting 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 for changes in the growth in healthcare costs, economic growth and the discount rate. Therefore we concluded that just as 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.
Introduction

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

Currently in the Netherlands healthcare expenditure is 9.8% GDP (gross domestic product) and rising each year (Roehr, 2010). This expenditure pattern is comparable to other European countries, i.e. United Kingdom 9.0% GDP and Germany 10.4% GDP (World Health Organisation, 2011). In vitro fertilisation (IVF) is sometimes seen by politicians, policy makers and the general public as a medical luxury product and therefore prone for health care cuts. In 2009, one out of 38 individuals born in the Netherlands was a result from IVF (Nederlandse vereniging voor obstetrie en gynaecologie, 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.

On 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 economic active adults in society. A calculation of lifetime tax revenues of IVF conceived individuals in the United Kingdom, United States 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; Connolly et al., 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, GA considers whether there will be sufficient tax revenue collected in the future to pay for government programmes and whether tax increases or other policy adjustments are necessary to cover government expenditures 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, we assessed the long-term economic benefits attributed to IVF-conceived individuals in the Netherlands. Furthermore, we extend 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 our model we assume the individuals to
be average in terms of education, earnings, and health. We also assume 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 (CBS, Statistics Netherlands, 2011a). 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: \( y = ax + b \). \( a \) 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, we can derive the net tax contribution or net tax deficit for an individual at any stage of life 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 healthcare, 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, \( t_P \);
(v) retirement: from \( t_P \) until death, \( t_D \).

In the health investment model, we assigned the following values 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 our model to represent an average individual, male and female (CBS, Statistics Netherlands, 2008). E.g. at the of 20 years 99% of the population is alive and 88% at the age of 60. Retirement age was set at 65, which is current policy in the Netherlands. Stages III and IV overlap, because between the ages of 16-29 a proportion of people attend secondary/tertiary education and a proportion attends employment (Organisation for Economic Co-operation and Development (OECD), 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.
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 (CBS) 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 (CPB) 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 (SVB).

**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 (CBS, Statistics Netherlands, 2011a).

**Transfers from the government to individuals**

**Healthcare costs**
IVF cost were 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 were €10,982 adjusted for inflation (CBS, Statistics Netherlands, 2011a). Our calculations were based on a 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 (Nederlandse vereniging voor obstetrie en gynaecologie, 2010).

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Table 1: Overview of government revenues and expenditures

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 (CBS) 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 (CPB) 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 (SVB).
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 B 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 financers than the government were excluded (National Institute for public health and the environment, 2008). In the model, we 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, which is obliged by the Dutch law. The costs for primary education were €5,300 and €7,107 for secondary education (Organisation for Economic Co-operation and Development (OECD), 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 (OECD), 2011). The average cost for tertiary education was €6,134. 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 that 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 until 30 years receive student financing in case they attend tertiary education. This finance is irrespective of the income of the parents. Dependable on the parent’s income, some students qualify for a supplementary grant. Calculated average cost per student per year were €6,130 (Informatie Beheer Groep, 2009). Average costs were adjusted according to the participation rate in tertiary education (Organisation for Economic Co-operation and Development (OECD), 2011).

**Child benefit**

Child benefit is part of the social security system in the Netherlands. It is known as the General Individual Benefit Act (AKW, Algemene Kinderbijslag Wet). All parents receive child benefit till the 18th birthday of their children (Sociale verzekeringbank, 2010). The amount of benefit is age dependent. Children below 5 years receive €774.92 per
year, children aged 6 to 11 €940.96 per year and for children aged 12 to 18 €1107.00 per year (Sociale verzekeringbank, 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. We calculated the average benefit, which was €106 per household (CBS, Statistics 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 €1207 for children aged 4-12 years (Dutch Government, 2009).

Adult related transfers
Average age and sex stratified income was obtained from the Statistics Netherlands, the Netherlands has a public available database with its costs and transfers (CBS, Statistics Netherlands, 2011b). 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 (CBS, Statistics Netherlands, 2011b). According to these tables all average transfers from the government to an individual in his adult live 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 (CBS, Statistics Netherlands, 2011b). 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 CBS, Statistics Netherlands), the transfers (income tax and duties) to the government could be calculated stratified by sex and age (CBS, Statistics Netherlands, 2011b).

Value added tax
Based on the disposable income, the government’s income by Value Added Tax (VAT) was calculated. We assumed that the whole disposable income would be spent (CBS, Statistics Netherlands, 2011b). 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 healthcare 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
healthcare and 3% on other expenses (donations, contributions). This leaves 46.1% for other goods and services (CBS, Statistics Netherlands, 2010b; CBS, Statistics Netherlands, 2010c).

Discount rate
To reflect the depreciation of money over time, we 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 criterium for establishing whether government action on programmes can be justified (HM Treasury, 2003). We applied a 4.0% discount rate to all costs (Health care insurance board, 2006).

Sensitivity analysis
In a sensitivity analysis we tested the uncertainty of our model. We performed one-way deterministic sensitivity analysis; tornado diagrams were used to present the results. The ranges in which the model was tested were changed with in 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 rate 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 life time 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- 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 outcomes at the age of 25, 50 and 100 of IVF conceived and natural conceived individual are shown in table 2.

Sensitivity analysis
We 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 in with the set ranges. Transfers based on income and education costs had the lowest influence. Threshold
analysis showed that if absolute education costs would decline with more than 94%, the net present value would be positive at the end of life. Also if transfers based on income would increase with more than 228%, transfers based on VAT would increase with 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 were the NPV became positive at the end of life.

Discussion

According to our 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.
Chapter 3

which showed a similar trend, but with a smaller negative return at the end of life, namely - $ 76,000 (index level 2008, - €52,456) (Bovenberg et al., 1999). The discrepancy between their calculation and our calculation can be explained by different factors.

First, our calculations are 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. We chose for the single household to be certain that income could only be described to one person. We assume that households consisting of more than one individual are more successful and therefore have a higher income and consequently pay more taxes.

Second, in our model we applied different rates for healthcare growth, economic growth and discounting, which are more valid now compared to 17 years ago. Finally, government policy on taxes and investments and the population distribution have changed considerably since 1995 (CBS, Statistics Netherlands, 2011d).

Net present value calculations in the United States, Sweden and United Kingdom have previously described a positive result at the end of life. Calculations in the US 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 our outcome cannot be extrapolated to other countries.

This is the first analysis that differentiates between men and women. In our analysis both men and women had a negative return at the end of life, but the negative return

![Tornado diagram](image)

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. Tornado diagram
of women ( - €123,177) was much higher compared to that of men ( - €47,091). This can partly be explained by the lower labour participation of women compared to men. In 2008 59.2% of all women were working, against 77.1% of all men from 15 years of age and up (CBS, Statistics Netherlands, 2010d). Also, if women work, this is more likely to be part-time, compared to men and the income of women is still lower than that of men, resulting in less income tax and VAT (CBS, Statistics Netherlands, 2011b).

Another explanation for the difference between men and women are the health care 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 e.g. it focuses on the policy effect on future generations and also takes future developments into account. These properties make 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 oversee at the moment of calculation, e.g. potential future changing in taxes. The results thus have to be interpreted with caution.

Our 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 we only take the cost per live birth into account irrespective of the cost transferred and gained in the rest of its life, the costs per life gained are €10,982 for a 30 year old mother. This is below the cost per life years gained threshold in the Netherlands, namely €20,000 per LYG (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 decreasing number of embryos transferred and consequently have 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 with more than 30% and a more than 50% reduction of twin pregnancies.(Ombelet W 2006) Reducing the health care costs caused by neonatal costs linked to multiple pregnancies, would save 85% of the IVF budget (Ombelet, 2006).

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 programs 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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