FEWER EMITTERS, LOWER EMISSIONS, LESS COST

REDUCING FUTURE CARBON EMISSIONS BY INVESTING IN FAMILY PLANNING

A COST/ BENEFIT ANALYSIS

Thomas Wire

August 2009

London School of Economics, Operational Research
LSE supervisor: Ian Lambert

Sponsoring Organisation: Optimum Population Trust

EXECUTIVE SUMMARY

The Client

This project has been commissioned by the Optimum Population Trust, a UK environmental charity and think tank, raising awareness of the environmental impact of population growth.

Purpose of the Project

The purpose of this project is to perform a cost-benefit analysis of reducing carbon emissions by non-coercively reducing population growth. The basic tenet of this project is that fewer people will emit fewer tonnes of carbon dioxide (CO2). The study estimates the cost-effectiveness of providing global access to basic family planning (as a major method of population growth reduction) in reducing future CO2 emissions between 2010 nd 2050. This finding is compared to other means of reducing CO2 emissions.

Methods Used

The cost of global family planning was calculated in one model and analysed against the estimated reduction in CO_2 emissions calculated in a second model. The cost-effectiveness of family planning was then compared to the cost-effectiveness of modern low-carbon technologies. The first model was developed to estimate the cost of providing family planning to all women who wish to delay or terminate childbearing but who are not using contraception i.e. all with *unmet need* for family planning. Recent data was inputted into the model primarily from the UN and the Global Health Council. A second model utilised UN projections for population levels and CO_2 emissions, adjusting values in accordance with increased access to family planning. This adjustment was based on a finding stated in the UN Population Fund's report, *Adding it Up: The Benefits of Investing in Sexual and Reproductive Healthcare* (Singh et al): meeting all unmet need will reduce unintended births by 72% (20).

Findings

The study found that each $7 spent on basic family planning (2009 US$) would reduce CO_2 emissions by more than one tonne (meeting all unmet need between 2010 and 2050). By comparison, a one tonne reduction in CO_2 emissions is predicted in Project Catalyst[1] to cost a minimum of $32 using low-carbon technologies (Project Catalyst 10): $25 more per abated tonne of CO_2 than family planning. This study also found that meeting all unmet need would prevent the emission of at least 34 Gt of CO_2 (gigatonnes of CO_2[2]) between 2010 and 2050 making the assumption that *demand* for family planning is not *stimulated* by family planning proposals.

Recommendations

From the cost-benefit analysis, it has been found that family planning (considered purely as a method of reducing future CO_2 emissions) is more cost-effective than most low-carbon technologies. It is recommended that an optimum mix of carbon-reducing methods includes family planning as one of the primary methods.

[1] "Project Catalyst is an initiative of the ClimateWorks Foundation, […] launched to provide analytical and policy support for the United Nations Framework Convention on Climate Change […] see www.climateworks.org" (Project Catalyst 5).

[2] 1 Gt = 1 gigatonne = 1 billion tonnes = 1×10^9 tonnes (metric tons)

TABLE OF CONTENTS

1.0 INTRODUCTION

This introduction includes an outline of the study's purpose. Section 1.2 describes the organisation commissioning the study followed by a background of the problem and an outline of the approach adopted. An orienting plan of the report is provided in section 1.4.

1.1 Objectives

This project aims to conduct a cost-benefit analysis of family planning in terms of reducing CO_2 emissions between 2010 and 2050. It is proposed that this benefit is achieved by the reduction in population growth rates that may result from increased spending on family planning.[3] The years 2010 to 2050 were modelled because family planning is not expected to *immediately* affect population levels or CO_2 emissions. The resulting reduction in population growth rates will take time to affect global population levels.

1.2 Background

The Organisation: Optimum Population Trust

The work for this project has been commissioned by the Optimum Population Trust (OPT). OPT is a "think tank in the UK concerned with the impact of population growth on the environment" (OPT). Since May 2006, OPT has been registered as a charity in Manchester, operating as a "virtual organisation" in practice. The organisation's main aims are:

- To advance the education of the public in issues relating to human population worldwide and its impact on environmental sustainability;
- To advance, promote and encourage research to determine optimum and ecologically sustainable human population levels in all or any part or parts of the world and to publicise the results of such research;
- To advance environmental protection by promoting policies in the United Kingdom or any other part or parts of the world which will lead or contribute to the achievement of stable human population levels which allow environmental sustainability.

(OPT)

The Problem

In 1992, UNICEF suggested that family planning's ability to compete with other technologies on cost-efficiency: "[f]amily planning could bring more benefits to more people at less cost than any other single 'technology' now available to the human race" (UNICEF).

This cost/ benefit analysis has been commissioned by OPT to investigate the effectiveness of population-growth-reduction through family planning in reducing CO_2 emissions. Straightforward comparisons are made with the cost of current

[3] The problem is discussed further in the 'terms of reference' document (appendix A), which outlines the purpose of the project and a proposed method as agreed in the initial stages of the study.

carbon-reducing methods. It is intended that the results that come from the study can serve as a starting point in illustrating whether population growth should have a place in carbon-reduction policy.

For OPT, the significance of this problem lies in establishing a recognition that global population growth should be discussed by government representatives and in the public eye. Success in demonstrating population issues with respect to carbon emissions may open the door for serious discussion on more active population policies.

1.3 Approach Adopted

The study first estimates the benefits (in terms of CO_2 emissions) by modelling world population projections. The cost (in 2009 US$) is then calculated using a second model.

Benefits

An important concept frequently discussed by many organisations including the Population Reference Bureau (PRB) is that of *unmet need.* This term is defined by John Guillebaud of OPT as the "[p]roportion of women who wish (in survey data) to delay or terminate childbearing but who are not using contraception" (Guillebaud 6).[4] A June 2009 PRB article (Ringheim et al.) claims that 200 million women globally have unmet need (1).

In *Adding it Up: The Benefits of Investing in Sexual and Reproductive Health Care* (Singh et al.), the United Nations Population Fund (UNFPA) found that meeting all unmet need would reduce unintended births by around 72% (20.) This UNFPA finding is the basis for the estimated effect of family planning on unintended births in this study. Such a result would have several implications. For the purposes of this study, the effect on population growth rate was modelled, allowing the reduction in population to be calculated.[5] This process was completed in the same manner for each year from now to 2050 using a spreadsheet model. Considering the average CO_2 emissions per capita in each country or region, the data was summed for all years in an operation to produce a total *benefit* of the proposal.

Cost

A spreadsheet model was again used to calculate the minimum number of people expected to have unmet need for each year between 2010 and 2050. In turn, a calculation was made to estimate the cost of family planning services necessary to assume that all unmet need can be met for each year. These costs were summed and divided by the *benefit* previously calculated to produce a cost per CO_2-tonne abated

[4] Guillebaud's definition is a fairly typical understanding of the term, although sometimes the additional criterion is given that contraception must be *modern* for a woman to not be classified as having unmet need.

[5]The justification in studying the relationship between unintended pregnancies and population levels comes from the high proportion of unintended pregnancies. According to the *All Party Parliamentary Group on Population, Development and Reproductive Health* (APPG), "41% of pregnancies globally are unwanted" (APPG *Summary* 3). The UNFPA report that "[a]s many as 50% of births are unplanned, and 25% are unwanted" (UNFPA *Contraceptive*).

i.e. the *mitigation potential* of family planning. In the context of this report, mitigation potential is the cost (in 2009 US$) per tonne of CO_2 abated in comparison to current projections.

"The Impact of Publicly Funded Family Planning Clinic Services on Unintended Pregnancies and Government Cost Savings" by Jennifer Frost et al. of the Guttmacher Institute was published in 2008. In the study, a saving of $4.02 was estimated on every $1 invested in family planning in the U.S. (Frost et al. 778). Since significant variation exists on such estimates of *return*,[6] this study applies family planning costs without subtracting savings resulting from any reduced levels in social services. The cost is given as a *positive* value with additional benefits noted. This approach, however, presents obstacles to analysis when comparing the mitigation potential of family planning to the mitigation potential of alternative energy sources. For example, while the cost found in this study could never be negative, Project Catalyst found that geo-thermal technology will have a cost of *minus* 9 US$ per CO_2-tonne abated in 2020 (Project Catalyst 10).

1.4 The Report

This report begins with a look at previous works relevant to the project (chapter 2), followed by a discussion of possible approaches that were considered (chapter 3). Chapter 3 includes descriptions of the approaches that were rejected for various reasons as well an explanation of the adopted approach. Chapters 4 and 5 explain the analysis behind the approach referring the reader to appendix B for the more technical explanations involved. The analysis is separated into two chapters to represent the two elements of a cost/ benefit analysis. Details of the data used are given (chapter 6), followed by conclusions and recommendations (chapter 7). A glossary defines technical or potentially ambiguous terms used in the report (chapter 8). The report includes references (chapter 9) and appendices. An OPT statement on climate change is included as an annex.

[6]Studies demonstrating a return on investment through family planning in wealthy countries include "Public Savings from the Prevention of Unintended Pregnancy: A Cost Analysis of Family Planning Services in California," which estimates a saving of $2.76 within 2 years and $5.33 within 5 years on every $1 invested (Amaral et al. 1960). "The Cost of Family Planning Service Provision" illustrates savings as a result of investments for several different contraceptive methods in the UK (Hughes and McGuire). Savings through social services as a result of investments in family planning in developing countries could be smaller in comparison to wealthier countries, but it should certainly be noted that each dollar invested in family planning may see savings as a result of reduced costs for social services.

2.0 PREVIOUS WORKS

Many existing studies consider the cost of family planning against several benefits. Other studies consider the benefits of reducing carbon emissions without addressing family planning or population-growth-reduction as a method. Although studies exist that do consider reduced carbon emissions as a result of reducing population growth, it is not clear that a quantitative cost/benefit analysis has been conducted in these cases. A discussion of some relevant previous works follows in chronological order.

2.1 Early Studies

Studies on population growth are relevant to this project, particularly if family planning is posed as a solution. As John Bligh discusses in *The Fatal Inheritance* (Bligh), studies concerning human population growth issues have been carried out since Adam Smith's 1776 account, *The Wealth of Nations* (Smith), provided a matter-of-fact economist's observation. Smith observed that resources limit the natural growth of *any* species (Bligh 32). Two decades later, Thomas Malthus wrote "An Essay on the Principles of Population" (Malthus). The historical relevance of Malthus' work in any family planning study cannot be understated. In fact, Richard Ehrman's *The Power of Numbers* (Ehrman) states that Malthus' "call for 'prudential restraint' – by which he meant later marriage – can be said to have opened the way for family planning" (33). Many of the older studies are insightful, but knowledge, policies and population behaviour has changed significantly even since Paul Ehrlich's influential 1968 book, *The Population Bomb* (Ehrlich). More recent works pertaining to the earth's *current* population growth should be considered.

In 1976, Robert H. Haveman's *Benefit-Cost Analysis and Family Planning Programs* (Haveman) addressed the need for a cost benefit analysis of publicly funded activities. The paper includes a number of general "propositions and conventions" (38) and a discussion of social benefits associated with family planning including a reduced "burden" (54) on public services. In our study, inputs and outputs are quite well defined and it is not the purpose of the study to undergo a quantitative analysis assigning value to any of the outputs beyond carbon emissions. Conducting a full analysis of family planning by measuring all costs and benefits would be impractical on a global level given all of the different implications that a change in population growth will have in different regions around the world. While acknowledging other benefits of family planning, the scope is to focus on a single benefit: reduced carbon emissions.

Deirde Wulf's 1981 special report, "Cost Benefit and Cost-Effectiveness Analysis for Family Planning" (Wulf), provides an appropriate distinction between cost-benefit analyses and cost-effectiveness studies in looking at averting births. Our study shares a property of Wulf's cost-effectiveness definition: the output in our study (reduced CO_2 emissions) "is assumed to be desirable" (142). We can, however, properly call our study a *cost-benefit analysis* because we can "place a monetary value on the output" (142) by comparing the result to currently accepted carbon reducing costs.

Several studies in the 1980s, including "A Cost-Benefit Analysis of Thailand's Family Planning Program" (Chao and Allen) and "A Cost-Benefit Analysis of the

Mexican Social Security Administration's Family Planning" (Nortman et al.) considered the costs and benefits of family planning programmes on a domestic level. Such studies tend to consider benefits in reduced "expenditures for social services" (Chao and Allen 75) and do not discuss benefits of more international concern like carbon emissions.

Published in 1994, *Methods for Costing Family Planning Services* (Janowitz and Bratt) can serve as a detailed manual for calculating the costs of many elements of family planning. Given the level of specificity in the report, it is demonstrated that different forms of family planning can involve dramatically different levels of cost. It also highlights that:

> One problem caused by these different approaches is that the term "cost" has lost some of its precision. It is difficult (if not impossible) to know whether the costs calculated in a given study can be meaningfully compared to those in other studies. (9)

The above problem is particularly relevant for this study since the global nature of the analysis may necessarily use a crude average of family planning costs. Consequently, it is critical to state precisely which costs are included in the value used.

In 1996, "The Cost-Effectiveness of Family Planning Service Provision" (Hughes and McGuire) adopted a method of dividing the total net cost by the number of pregnancies averted for different contraceptive methods. This produced a range of values for the cost of each pregnancy averted (192). Although the estimates are based on practice in the UK and the calculations are more focused on family planning beyond the basic levels proposed in this study, the method could be a basis for the some elements of calculation.[7]

2.2 Twenty-first Century Studies

The Global Health Council's 2002 publication, *Promises to Keep: The Toll of Unintended Pregnancies on Women's Lives in the Developing World* analyses "the consequences of unintended pregnancy" (Daulaire et al. 3). Although these consequences do not specifically include carbon emissions, reduced social costs and rates of maternal mortality (resulting from fewer unintended pregnancies) are likely to be additional benefits of the proposal in this study.[8]

The 2003 report, *Adding it Up: The Benefits of Investing in Sexual and Reproductive Health Care* (Singh et al.), proposes meeting unmet need for family planning as a method for reducing population growth as well as other goals. When considering "meeting need" as an approach for population reduction, certain assumptions will have to be made. One such assumption recognised in the report is that:

[7] It is worth noting that if pregnancies are considered rather than live births, more data is required to establish how pregnancies effect population growth because abortions and other factors must be taken into account.

[8] The effect of family planning on maternal mortality is studied more recently in the fourth edition of the Population Refernce Bureau's 2009 report, *Family Planning Saves Lives* (Smith et al.). The report also discusses the effect of family planning on reducing infant mortality.

> If contraceptive services were available, many—but not all—of the 201 million women in developing countries with unmet need would adopt a modern method. Some women will always have problems with modern methods, as a result of side effects, misconceptions, cultural values or personal preference. At the same time, however, some women who are not considered to have an unmet need (usually because they plan to have a child soon) say they intend to use a modern contraceptive method.
>
> (19)

Although the above assumption may not dramatically affect calculations of mitigation potential, it may affect the possible level at which the proposal can be implemented.

The report also gives estimated costs for different elements of family planning on a global level. In doing so, the assumption is made that those whose needs are met behave in a similar way to those locals who currently access family planning methods (19). Following the basic analysis, the report considers family planning methods in "the larger context of how they contribute to economic development and social wellbeing" (22).

A relevant point is raised in the 2005 publication *Profiles for Family Planning and Reproductive Health Program* (Ross et al.). Care should be taken in any study modelling the meeting of unmet need because *reducing* demand for family planning is generally not an acceptable outcome. That is, "the unmet need estimates should be reduced for women who do not intend to use, but increased to recognize omitted couples who intend to use a method" (50). The report also demonstrates that unmet need cannot be entirely predicted by the availability of family planning (or contraceptives).

The All Party Parliamentary Group's (APPG) 2007 report, *Return of the Population Growth: Its Impact upon the Millennium Development Goals* cites many benefits of family planning in the context of seven millennium development goals. It is stated that "[l]arge families are usually not the choice of the poor, but a result of their inability to exercise their options to manage their family size" (APPG 9). A pertinent observation to this study is made:

> Population growth is exacerbating problems in environments already left vulnerable by climate change. Population pressures are adding to the difficulty in the achievement of environmental sustainability, particularly regarding agricultural lands, forests, water and biodiversity.
>
> (47)

It is also stated that "[i]mproved access to family planning is one of the most cost-effective ways of reducing infant and maternal mortality" (8), as well as leading to "economic progress" (8) and improved opportunities to "invest in education and health" (8). In addition, a reduction in unintended pregnancies (and hence, population growth) is shown to help with issues of hunger, civil conflict, water shortages, unsafe abortions, deforestation and agriculture.

When we consider proposals to reduce population growth, a 2007 observation made by John Guillebaud in "Youthquake: Population, Fertility and the environment in the 21st Century" (Guillebaud) is relevant. Guillebaud stated that "[p]opulation growth is

not just a problem for the developing world" (2). Although we can expect that different cultures might respond to family planning in different ways, a reasonable study will consider unmet need in developed regions as well as the developing world. Guillebaud also points out that 350 million couples do not have full access to family planning services (2)—significantly more than those defined as having unmet need. While this study primarily considers those who *already have* unmet need, it is noted that the demand for services has the potential to increase up to 350 million.

Guillebaud proposes removing "obstacles to birth control" (22). From an analytical standpoint, the cost of removing such obstacles may represent a significant element of family planning's cost. The scale of these obstacles can not be reasonably predicted within the scope of this study, but the reader should be aware that political and cultural obstacles in implementing family planning may represent *additional* costs.

In this study, the *mitigation potential* of family planning is calculated. The term mitigation potential is used as by the Intergovernmental Panel on Climate Change (IPCC). Their *Climate Change 2007* synthesis report (Bernstein et al.) explains that:

> The concept of 'mitigation potential' has been developed to assess the scale of *[greenhouse gas]* reductions that could be made, relative to emission baselines, for a given level of carbon price (expressed in cost per unit of carbon dioxide equivalent emissions avoided or reduced). Mitigation potential is further differentiated in terms of 'market mitigation potential' and 'economic mitigation potential'.
>
> (58)

Last year, in an *Outlook* article, the UNFPA looked at the social benefits are associated with family planning. Giving the fact that "about one in six married women still has an unmet need for family planning" (Kols 1) and that "[a]s a consequence, 76 million women in developing countries still experience unintended pregnancies each year" (1), meeting unmet need should be a goal of family planning. In order to reduce unmet need, the article mentions "redesigning delivery systems" (4) and methods for overcoming barriers. These kind of practical implementation issues are factors that should be considered in addition to the cost-effectiveness in this study as well as the cultural issues that are well discussed in the UNFPA's *State of World Population 2008.*

"Managing the Health Effects of Climate Change" (Costello et al.) is a recent article published in *The Lancet*, discussing population growth's role in CO_2 emissions. The prediction is made that "[p]opulation growth will increase overall emissions in the long term and expand the number of vulnerable individuals" (1695) including a "substantial rise in CO_2 emissions" (1708). Effective family planning's impact on population growth is apparent by the article's finding that "[m]odest changes in fertility have large effects on population growth" (1707). While this study assumes no relative change in the *demand* for family planning, "Managing the Health Effects of Climate Change" found that demand is expected to increase. The possibility of providing family planning for more than those claiming to have "unmet need" is implied because "[d]emand for family planning is expected to increase in the next 15 years as millions of young people become sexually active[9]" (1719).

[9]The UNFPA predict that unmet need will grow by 40% in the next 15 years (UNFPA, Family Planning)

In an OPT briefing (McDougall and Guillebaud), Rosamund McDougall and John Guillebaud used data from the UN's World Population Data sheet to demonstrate the degree of world population growth. This includes projections up to 2050 and highlights these figures in relation to the earth's resources. The connection is also made between per-capita CO_2 emissions and population levels. While the practice of setting population policies in individual countries is mentioned, one of the proposed solutions is to provide contraception to prevent unwanted pregnancies.

2.3 Conclusions from Previous Studies

Several studies discussed above have demonstrated the cost-effectiveness of family planning over many decades. Generally these studies find the benefit with respect to controlling disease and reducing costs for social services. Studies that consider family planning as a method of reducing population growth consider several benefits of reduced population growth including reducing carbon emissions (sometimes extended to reducing climate change). This study attempts to take a step of actually *quantifying* the cost applied to family planning in relation to the benefit in terms of CO_2 emissions.

3.0 APPROACH

This chapter considers how decisions were made in view of the project goals and possibilities. Included is a brief explanation as to why an action proposal is required before any analytical method followed by a discussion of approaches that might have been options. Section 3.2 outlines the approach that was ultimately used.

It has been mentioned that the purpose of the project is to calculate the extent to which CO_2 emissions can be reduced by increasing accessibility to family planning. While the goal of the project is clear, a proposed method for achieving the goal had to be established. Increasing the amount of money spent on family planning does not *directly* reduce CO_2 emissions and therefore a line of logic from 'spending money' to 'reducing CO_2 emissions' must be proposed as shown below in figure 3.0.1.[10]

[10] In figure 3.0.1, the arrows (→) should be interpreted as "…may directly have the benefit of…"

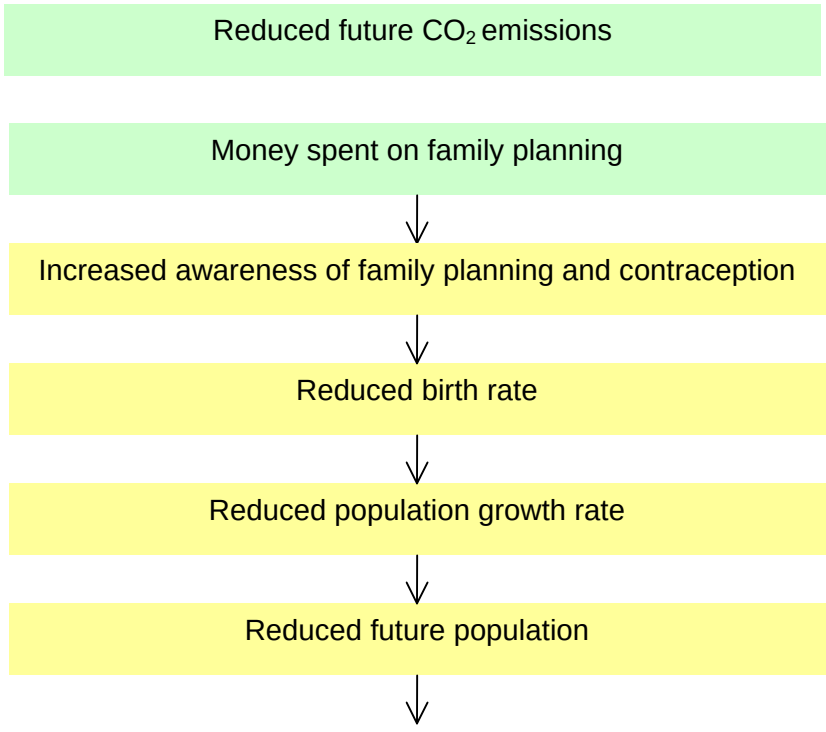

Figure 3.0.1

Figure 3.0.1 represents one 'line' of figure C.1 that presents other possible benefits of spending on family planning (appendix C). Given the five 'steps' from action to goal, it becomes clear that establishing a proposal before being able to analyse the problem quantitatively is nontrivial. Questions arise at each step: *How much is being spent? Where in the world is family planning being made more accessible? How many people will have improved access to family planning?* A proposal must include answers to these types of questions before we can make other calculations including the effect contraception use is likely to have on birth rates and how population growth rates will impact population levels in every year before 2050.

3.1 Rejected Approaches

The first considered proposal involved providing family planning with the goal of increasing contraceptive use.[11] In particular it would have been proposed that the appropriate level of family planning is provided to all countries below a particular percentage of contraceptive users. If, for example, 50% is used as a target for all countries, about 109 countries worldwide would require increased funding. A variable that is likely to directly impact future population levels (birth rates or total fertility rate, to give two examples) can be compared to contraception use and a regression model can be developed to predict birth rates for any given level of contraceptive use. Given new birth rates in the relevant countries, calculations can be made to project new projected populations.

There are a number of problems and assumptions with the approach described above. It would have to be assumed that contraceptive use and family planning are very well correlated. Another problem is that many countries, where contraceptive use is less than 50%, may have several obstacles to widespread contraception use that family planning cannot be assumed to 'fix.' Some cultures, with or without family planning, may have higher birth rates. If countries implement different levels of family planning *with different results*, identifying an accurate predictor of contraception use, based on money spent, would be highly inaccurate. Perhaps most critically, the above approach only considers an improvement to family planning where birth rates are high and presents a false dichotomy for the level of contraception use in that each country is either above or below the target. In attempting to correct this problem, a very high target could be selected, but the regression model can only be assumed as reasonable within some range.

Because we can not be certain of all the reasons for each country's birth rate, any reasonable and non-coercive proposal must primarily meet a global *need* of family planning. In turn, the effect of this approach can be calculated. It is for this reason that the next proposal considered unintended pregnancies globally.

A method that would combine the cost and benefit elements of the study would be to compare the amount of money a country has invested in family planning per capita against the number of unintended pregnancies per capita. A regression model could be used to predict the amount that governments should expect to need to invest in family planning in order to achieve a certain goal for unintended pregnancies. There are problems associated with this method. A 'goal' must be stated for unintended pregnancies. If a very low number is proposed, the regression model is forced to predict based on an extreme value reducing the accuracy of the prediction. Indeed, the countries with the lowest rate of unintended pregnancies may be investing in different forms of family planning or population control methods that do not meet the aims of OPT. Even if data for each country's spending on a specific form of family planning could be found, all data could not account for population control laws, political circumstances or cultural factors. Data of this nature is also not likely to account for the increased availability of family planning and contraception through private companies.

[11] For the purposes of this discussion, only *modern methods* of contraceptive use are considered. *Modern methods* are defined in the glossary.

A relatively simple calculation to meet a consistent measure of family planning need would be more appropriate. An estimate on global unmet need for family planning is available from the UNFPA (Singh et al. 19) and is a good indicator of the likely response to non-coercive family planning. A model that assumes to provide basic family planning to all with unmet need would not be unreasonable given that mitigation potential will ultimately be calculated i.e. we would not *necessarily* be expecting to meet all unmet need successfully. The global population would be projected to 2050 assuming that unintended births are avoided.[12] The problem with this method is that many approximations must be made by making broad calculations for the whole world. For example, CO_2 emissions per capita (which will be calculated to find the *benefit* of the proposal) will use a crude average. Such an approximation may lead to a massive over-estimate if most countries with a high rate of unmet need emit less CO_2 than the world average. With this method, each country must be calculated separately for any degree of accuracy as explained in the following section.

3.2 Adopted Approach

The adopted approach analyses the benefit[13] of maximally reducing unintended births worldwide against the cost of satisfying unmet need for basic family planning. This cost is assumed to be equal to the cost of maximally reducing unintended births on the assumption that any woman giving birth as a result of an unintended pregnancy has an unmet need for family planning by the definition of *unmet need*.

To calculate both the benefit and cost of the proposal, a spreadsheet model was created. The purpose of using the spreadsheet model was to make calculations efficiently for all countries individually. This allows for the distribution of family planning to be weighted effectively in direct relation to need. In addition, the use of a spreadsheet model means that population growth rates and per capita CO_2 emissions can be inputted for each country. This approach is more accurate than using a crude average. There are few major assumptions. It is assumed that basic family planning can be provided for the same cost per person in all regions of the world and that those people claiming to have an unmet need for family planning will respond to basic family planning by a 72% reduction in unintended births.[14] It is also assumed that this proposal is performed for *all* people with unmet need and no more i.e. increased spending in family planning will not stimulate (or reduce) demand.

The various phases of the calculations follow in their necessary order. Note that a detailed explanation of each stage is covered in the next chapter.

[12] It should be noted that a model assuming unintended births will be eradicated (resulting from *some* of those with unmet need,) must consider that family planning has to be provided to *all* with unmet need (at least).

[13] The benefit of the proposal (reducing unintended pregnancies as greatly as possible) in this study is determined by the projected number of carbon tonnes emitted without the proposal minus the projected number of carbon tonnes emitted with the proposal between 2010 and 2050.

[14] It is claimed by UNFPA that meeting unmet need would reduce unintended births by 72% (Singh et al. 20)

Stages of Benefit Calculation[15]

(1) Inputted each country's population level projection for each year 2009 to 2050 from data (UN Population Division)

(2) Summed all projected population levels for each country to find *people-years*[16] lived between 2010 and 2050

(3) Inputted the average number of CO_2-tonnes emitted per capita per year from UN Statistics Division (UNSD)

(4) Multiplied data calculated in (2) by data inputted in (3) to calculate projected total CO_2 tonnes emitted by each country 2010 to 2050

(5) Summed all countries CO_2 emissions to calculate projected global CO_2 tonnes emitted 2010 to 2050

(6) Inputted average annual unintended births for each country calculated from Global Health Council (GHC) data (Daulaire et al. 42-46)

(7) Calculated 72 percent of average annual unintended births for each country using (6). These are considered to be *preventable unintended births.*

(8) Calculated projected 2010 population level for each country *with proposal* by taking 2010 projections minus the data calculated in (7)

(9) Inputted projected growth rates for each country, for each year 2009-2050 (UN Population Division)

(10) Calculated the 2009-2010 population growth rates for each country *with proposal*

(11) Calculated the effect of preventable unintended births on growth rate for each country. This was done by taking 2009-2010 growth rate inputted in (9) minus calculated growth rate in (10)

(12) Calculated projected population growth rates for each country for each year 2010-2050 *with proposal* by taking inputted data from (9) minus calculated data from (11)

(13) Calculated projected population levels for each country for each year 2011-2050 *with proposal* by using relevant population growth rates

(14) Summed all projected population levels for each country to find *people-years* lived between 2010 and 2050 *with proposal*

(15) Multiplied data calculated in (14) by data inputted in (3) to calculate projected total CO_2 tonnes emitted by each country 2010 to 2050 *with proposal*

(16) Summed all countries CO_2 emissions to calculated projected global CO_2 tonnes emitted 2010 to 2050 *with proposal*

(17) Calculated total abated CO_2 emissions 2010 to 2050 by taking single figure (5) minus single figure (16)

Stages of Cost Calculation

(18) Calculated proportion of world unmet need in 2009. This is world unmet need divided by world population (UN Population Division)

(19) Summed populations of all countries for each year 2009-2050 *with proposal* to find world projected population each year *with proposal*

(20) Calculated global demand for family planning each year 2009-2050 *with proposal* by multiplying calculated data in (18) by calculated data in (19)

[15] All United Nations Population Division data refers to 'medium variant' values

[16] One person-year represents the consumption of one person living on earth for one year

(21) Calculated cost to meet demand each year 2009-2050 by multiplying cost of basic family planning per person (calculated from UNFPA data) by calculated data in (20)

(22) Summed data in all years 2009-2050 calculated in (21) to find total cost of proposal

The cost of preventing each CO_2 tonne emitted was calculated by dividing the cost found in (22) by the benefit found in (17). The cost was then compared to other methods of reducing CO_2 emissions.

4.0 BENEFIT ANALYSIS

This chapter is the first of two to provide a description of the work carried out. In both of the following chapters, the reader is referred to appendix B for appropriate technical calculations. A benefit analysis provides details of the calculation for the abated CO_2 emissions under the proposal of reducing unintended births.

In designing the spreadsheet model, total CO_2 emissions were estimated with and without the family planning proposal. Various data sources were used. Chapter 6 discusses issues relating to the use of data sources. A complete list of assumptions made is included in appendix B.

4.1 Analysis without *Family Planning Proposal*

Tables 4.1.1 and 4.1.2 on the following page show the format for the part of the model pertaining to calculations *without* the family planning proposals. Eight countries have been selected for illustrative purposes.

Data on population growth (UN Population Division) for each of 222 countries in the following time periods were used: 2010 to 2015, 2015 to 2020, 2020 to 2025 and 2045 to 2050. A precise definition of this population growth rate, given by a percentage, can be found in the glossary. Since growth rates do not tend to change very rapidly within the time periods we are looking at, it seems reasonable that each year is approximated by being grouped into a five-year period. Because growth rates projections are approximately linear, linear interpolation was used to calculate the population growth rate in each year from 2025 to 2045. This process is explained in appendix B. Using the population growth rates, population levels were calculated for each country, in each year, 2010 to 2050. The formula used is presented in appendix B. Data for the years 2009, 2015 and 2050 were directly inputted for each country from the UN Population Division data.

All projected population levels for each country were summed to find *people-years* lived between 2010 and 2050 (table 4.1.1, column H), followed by the annual number of CO_2 tonnes emitted per capita (UNSD) shown in column I of table 4.1.1. Multiplying produced the projected total CO_2 tonnes emitted by each country, 2010 to 2050 (table 4.1.1, column J). Summing for all countries produced the projected CO_2 tonnes emitted globally from 2010 to 2050: 1.33 trillion tonnes.[17]

[17] For the purposes of this study, one *trillion* tonnes represents 10^{12} tonnes or 1 teratonne (Tt.) Therefore 1.33 trillion is 1.33×10^{12} tonnes.

Projected Population and CO_2 Emissions for Selected Countries *without Family Planning Proposal*[18]

A	B	C	D	E	F	G	H	I	J
Country	**Projected Population (000s)**						**Total people-years 2010-2050**	**Annual CO_2 emitted per capita**	**Total CO_2 Tonnes 2010-2050 (000s)**
	2009	**2010**	**2011**	**2012**	**…**	**2050**			
Afghanistan	28,150	29,138	30,101	31,095		73,938	2,098,936	0.03	62,968
Bermuda	65	65	65	65		63	2,675	8.6	23,003
China	1,345,751	1,354,256	1,362,542	1,370,879		1,417,045	59,140,710	3.84	227,100,325
Guyana	762	762	760	759		558	28,426	1.95	55,431
India	1,198,003	1,215,258	1,230,790	1,246,520		1,613,800	60,208,409	1.2	72,250,091
Kenya	39,802	40,867	41,926	43,014		85,410	2,598,662	0.31	805,585
UK	61,565	61,898	62,221	62,545		72,365	2,780,883	9.4	26,140,298
USA	314,659	317,694	320,566	323,465		403,932	15,083,942	20.4	307,712,421

Table 4.1.1

Projected Population Growth Rates for Selected Countries *without Family Planning Proposal*

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
Country	**Projected Growth Rate**															
	2010-2015					**2015-2020**					**…**	**2045-2050**				
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	…	2045	2046	2047	2048	2049
Afghanistan	3.25	3.25	3.25	3.25	3.25	2.9	2.9	2.9	2.9	2.9		1.63	1.63	1.63	1.63	1.63
Bermuda	0.15	0.15	0.15	0.15	0.15	0.11	0.11	0.11	0.11	0.11		-0.32	-0.32	-0.32	-0.32	-0.32
China	0.61	0.61	0.61	0.61	0.61	0.5	0.5	0.5	0.5	0.5		-0.33	-0.33	-0.33	-0.33	-0.33
Guyana	-0.19	-0.19	-0.19	-0.19	-0.19	-0.25	-0.25	-0.25	-0.25	-0.25		-1.61	-1.61	-1.61	-1.61	-1.61
India	1.27	1.27	1.27	1.27	1.27	1.1	1.1	1.1	1.1	1.1		0.25	0.25	0.25	0.25	0.25
Kenya	2.56	2.56	2.56	2.56	2.56	2.28	2.28	2.28	2.28	2.28		1.27	1.27	1.27	1.27	1.27
UK	0.52	0.52	0.52	0.52	0.52	0.49	0.49	0.49	0.49	0.49		0.29	0.29	0.29	0.29	0.29
USA	0.9	0.9	0.9	0.9	0.9	0.82	0.82	0.82	0.82	0.82		0.36	0.36	0.36	0.36	0.36

Table 4.1.2

[18] Tables 4.1.1 and 4.1.2: Data sources: Population and growth rates (UN Population Division). Emissions (UNSD). Tables are for illustrative purposes in demonstrating calculations. The figures shown are those used in calculation and not representative of the data's accuracy.

4.2 Analysis with *Family Planning Proposal*

Now that data had been analysed based on current projections, estimations were made on the impact of the reducing unintended births on CO_2 emissions. Please refer to tables 4.2.1 and 4.2.1 on the following page to view the format for eight selected countries. Unintended births from 1995-2000 (six full years) were inputted from data (GHC). See table 4.2.1, column B. 72% of the annual average over this period was calculated as preventable unintended births (table 4.2.1, column C), under the assumption that the number of unintended births annually at the end of the nineties was linear and relatively constant.[19] It was assumed that this number of births can be prevented in 2010 and therefore the 2010 projected population level with the family planning proposal was calculated:

2010 projected population level with family planning proposal =
2010 projected population level – 72% of average number of annual unintended births

Based on the 2010 projected population level with the family planning proposal, a new population growth rate was estimated (table 4.2.3, column D) by using the formula in appendix B based on the definition of population growth (UN Population Division). This new growth rate was compared to the original growth rate (table 4.1.2, column B) and the difference was calculated as the effect of preventable unintended births on the growth rates (table 4.2.2, column B). With this figure found for each country, population growth rates with the family planning proposal were calculated based on the original growth rates minus the effect of preventable unintended births. An example is provided in appendix B.

With population growths for each year listed, projected population levels were calculated based on the method referred to above and described in appendix B. As with the original data, the data pertaining to projections *with* the family planning proposal were used to calculate the total number of CO_2 emissions between 2010 and 2050: 1.28 trillion tonnes.

---

[19] The reason for assuming that the number of unintended births was relatively constant between 1995 and 2005 is partly out of necessity: a reliable source of recent data on unintended births was not found to provide data on every country for single years. In fact, if such data *does* exist, its accuracy should be questioned given the timeliness of collecting such data. In addition, calculating an annual average based on six years has an advantage: considering one year in any country carries a risk that the year is particularly unusual and therefore not representative of the normal rate for unintended births. Evaluating several years increases the chances that data is more representative of each country.

Another point is noted on data for unintended births: caution was taken in comparing data with figures given in other reports and studies. Many studies distinguish between unintended, unwanted and mistimed pregnancies. Generally unintended births are calculated from unintended pregnancies (as is the case with data used in this project). As a result, figures tend to rely on the accuracy of data on abortions—which could be highly unreliable, particularly in the many countries where abortion is illegal. For these reasons, a credible cross-comparison to confirm the accuracy of our average is not possible.

Because the number of unintended births is used largely to calculate the limit with which the proposal can be implemented, rather than the actual cost/benefit of family planning, accuracy in the figure is not absolutely essential to the study. For the reasons mentioned above, our figures are likely to be underestimates rather than overestimates, and therefore underestimate the scale with which the family planning proposal can be implemented rather than the cost/benefit of basic family planning.

Projected Population and CO_2 Emissions for Selected Countries *with Family Planning Proposal*[20]

A	B	C	D	E	F	G	H	I	J	K	L
Country	**Number of Unintended Births 1995-2000**	**Preventable Average Annual Unintended Births**	**Population (thousands) each year**						**Total people-years 2010-2050**	**Annual CO2 emitted per capita**	**Total CO2 Tonnes 2010-2050 (000s)**
			2009	**2010**	**2011**	**2012**	**...**	**2050**			
Afghanistan	968,155	161,359	28,150	29,022	29,861	30,725		63,266	1,910,283	0.03	57,308
Bermuda	840	140	65	65	65	65		60	2,601	8.6	22,370
China	9,713,642	1,618,940	1,345,751	1,353,090	1,360,198	1,367,342		1,382,160	58,109,479	3.84	223,140,400
Guyana	19,403	3,234	762	759	755	752		494	26,767	1.95	52,196
India	13,416,406	2,236,068	1,198,003	1,213,648	1,227,531	1,241,573		1,549,533	58,545,889	1.2	70,255,067
Kenya	987,904	164,651	39,802	40,748	41,684	42,640		75,979	2,429,315	0.31	753,088
United Kingdom	272,055	45,343	61,565	61,866	62,155	62,447		71,358	2,750,493	9.4	25,854,631
United States	2,129,065	354,844	314,659	317,439	320,051	322,685		394,001	14,824,758	20.4	302,425,061

Table 4.2.1

Projected Population Growth Rates for Selected Countries *with Family Planning Proposal*

A	B	C	D	E	F	G	H	N	O	P	Q	R	S
Country	**Effect of preventable unintended**	**Projected Growth Rate**											
			2010-2015					**...**	**2045-2050**				
		2009	**2010**	**2011**	**2012**	**2013**	**2014**	**...**	**2045**	**2046**	**2047**	**2048**	**2049**
Afghanistan	0.40	3.05	2.85	2.85	2.85	2.85	2.85		1.23	1.23	1.23	1.23	1.23
Bermuda	0.15	0.10	0.00	0.00	0.00	0.00	0.00		-0.47	-0.47	-0.47	-0.47	-0.47
China	0.09	0.54	0.52	0.52	0.52	0.52	0.52		-0.42	-0.42	-0.42	-0.42	-0.42
Guyana	0.31	-0.37	-0.50	-0.50	-0.50	-0.50	-0.50		-1.92	-1.92	-1.92	-1.92	-1.92
India	0.13	1.30	1.14	1.14	1.14	1.14	1.14		0.12	0.12	0.12	0.12	0.12
Kenya	0.29	2.35	2.27	2.27	2.27	2.27	2.27		0.98	0.98	0.98	0.98	0.98
UK	0.05	0.49	0.47	0.47	0.47	0.47	0.47		0.24	0.24	0.24	0.24	0.24
USA	0.08	0.88	0.82	0.82	0.82	0.82	0.82		0.28	0.28	0.28	0.28	0.28

Table 4.2.2

[20] Tables 4.2.1 and 4.2.2: Data sources: Unintended births (Daulaire et al. 42-46). Population and growth rates (UN Population Division). Emissions (UNSD). Tables are for illustrative purposes in demonstrating calculations. The figures shown represent those used in calculation and not representative of the data's accuracy.

4.3 The Benefit of Family Planning

A straightforward operation produces the total number of CO_2 tonnes abated by the proposal. This value was defined by the projected global CO_2 emissions from 2010 to 2050 *without* the family planning proposal minus the projected CO_2 emissions globally from 2010 to 2050 *with* the family planning proposal: **34 Gtonnes of CO_2**.

Summing the populations of all countries for each year produces a projected world population, assuming unintended births are reduced by 72%. A comparison of this projection to current variants (UN Population Division) is illustrated in figure 4.3.1 below. It can be seen that the projected population with the family planning proposal falls in the range between high variant and low variant and is predictably less than the medium variant. According to findings from the model, family planning can reduce the global 2050 population by almost half a billion—a reduction of over 5% on the current medium variant projections.

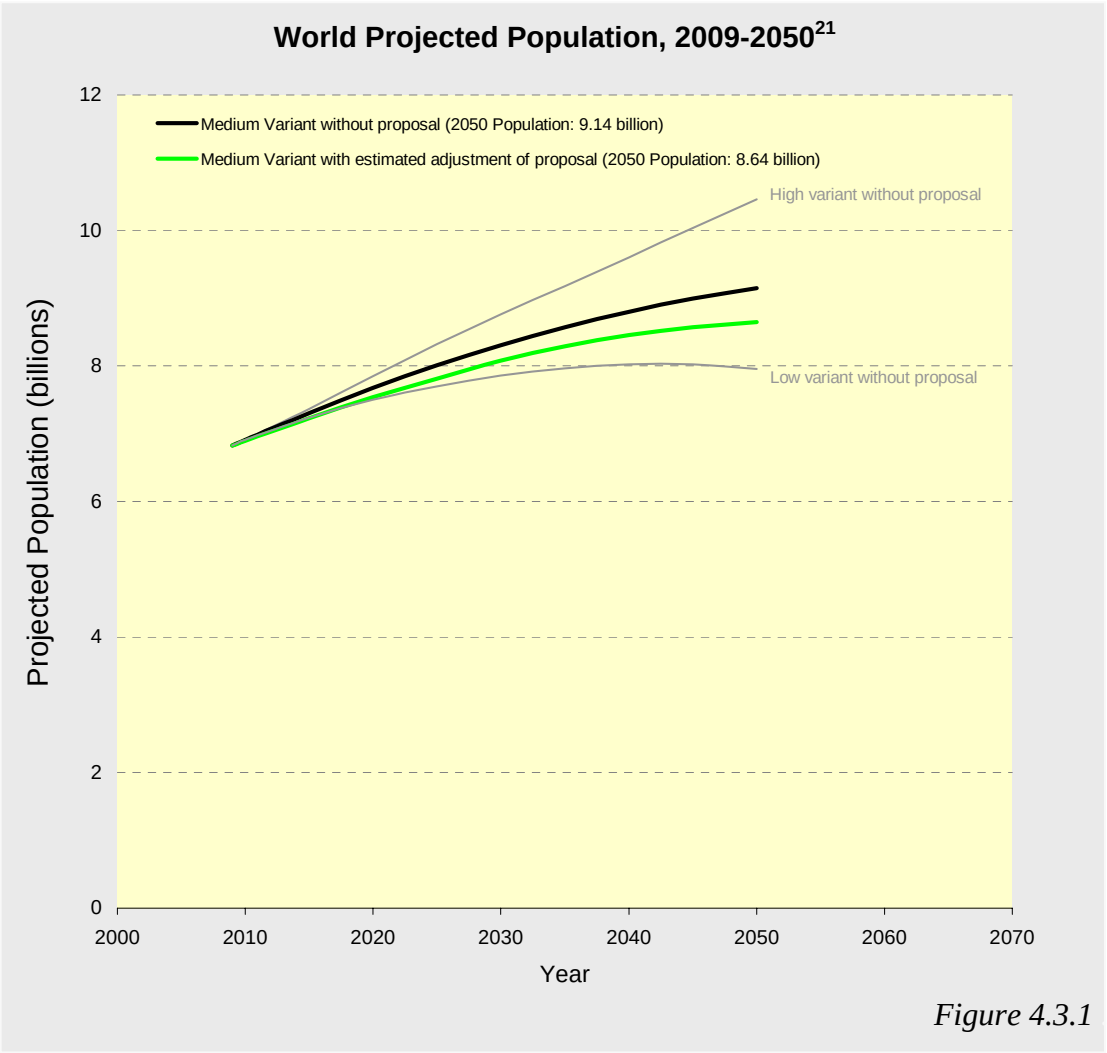

Figure 4.3.1

[21] All population projections without the proposal are from UN Population Division. The population projection *with estimated adjustment of proposal* represents data calculated by the analysis discussed.

Under the proposal, it is interesting to consider the countries that we could expect to see the greatest reduction in CO_2 emissions over four decades (see table 4.3.1).[22]

Countries Expected to See Largest Reduction in CO_2 Emissions with Proposal

Abated CO_2 Emissions Estimated from Family Planning Proposal, 2010- 2050 (Gtonnes)	
United States	5
China	4
Russian Federation	3
India	2
South Africa	1
Mexico	1

Table 4.3.1

4.4 Testing of Benefit Findings

By observation, the modelled population levels projected with the family planning proposal appear reasonable in two ways. Firstly, for all years between 2010 and 2050, the population levels are between the UN Population Division's 'medium variant' and 'low variant.' Secondly, the projection growth rate behaves comparably to the population growth rates for 'low variant' projections and 'medium variant' projections—and always between the two.

In general, it is recognised that projection models can be tested by applying the model to previous years. In this case, however, no data exists pertaining to previous population levels under the condition of meeting all global need for family planning.

[22] It should be recognised that the figures in table 4.3.1 could be subject to significant variation if other social factors are considered. Section 7.2 discusses some of these issues that could be addressed in an extended model. Many such issues would be very difficult or impossible to quantify and are beyond the scope of this project.

5.0 COST ANALYSIS

This chapter details the work carried out to estimate a total cost of providing family planning for all with unmet need.

With the world's current population, UNFPA state that total unmet need stands at around 201 million (Singh et al. 19). This fact means that approximately 3% of the world's population are women with unmet need.[23] It was assumed that this percentage represents the additional demand for family planning services and was taken as such for all future years. Using a spreadsheet model the world population projections were inputted for each year 2010 to 2050 and 3% of the world's population was calculated for each year. For example, in the year 2050 the population was projected to be about 8.4 billion people with the family planning proposal and it was assumed that the additional demand for family planning will be almost 250 million. The estimated cost of meeting this demand for each year was calculated by multiplying the demand by US$22.70—the UNFPA's estimated annual cost of basic family planning per capita[24] (Singh et al. 19). Figure 5.0.1 illustrates the components of this cost.

The Annual Costs of Basic Family Planning (US$ Per Capita)[25]

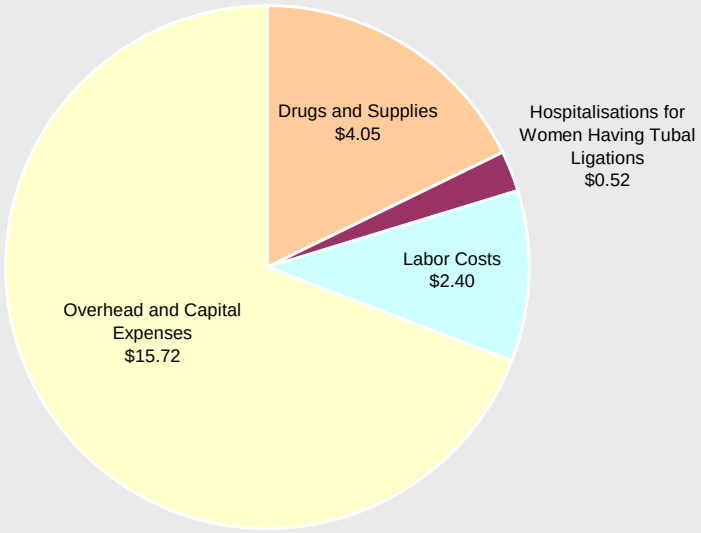

Figure 5.0.1

The costs were summed to produce an estimated total cost of the entire proposal for 2010 to 2050 at just over $220 billion — this would represent about $1.50 per person

[23] It is accepted that family planning concerns men *and* women, but for the purposes of this study, we assume couples seek family planning and therefore 201 million women with unmet need represent 201 million *couples* who are at risk of unintentional pregnancy.

[24] UNFPA figures on family planning costs are provided for meeting an unmet need of 201 million. Figures are adjusted for 2009 using the average consumer price index from the US Bureau of Labor and Statistics. The per-capita costs may not be accurate when applied to fewer people (if there are economies of scale), but this study applies the figures to *at least* 201 million annually.

[25] Data source: Singh 19

in the world per year.[26] To complete the cost-benefit analysis, the total cost was divided by the total benefit. The mitigation potential of basic family planning was calculated as **$6.46 to avoid the emission of each tonne of CO_2**. The specific calculation is presented in appendix B.

Insight can be gained by comparing the estimated cost of the discussed family planning proposal to estimates for costs of other emission-reducing technologies or proposals in table 5.0.1. Cost-effective technologies presented by Project Catalyst have been selected (Project Catalyst). Figures are given in CO_2 equivalent units (CO_2e) to standardise the global warming potential of the greenhouse gases.

Cost-Effectiveness of Family Planning Compared to Selected Carbon Reducing Technologies and Proposals[27]

	$/ tCO$_2$e	
	2020	2030
Geo-thermal	-9	-11
Sugar Cane	6	-5
Family Planning Proposal[28]	7	7
Reduced Deforestation[29]	13	-
Switch-Grass	18	8
Wind	24	26
Solar	51	24
Coal CCS New Built	57	56
Coal CCS Retrofit	83	69
Plug-in Hybrids	92	-8
Electric Vehicles	131	62
Total Low Carbon Technologies	**32**	**30**

Table 5.0.1

[26] The model estimates that, with the family planning proposal, a total of around 326 billion people-years would be lived between 2010 and 2050. This compares to almost 338 billion people-years using current projections.

[27] Data on geo-thermal, sugar cane, switch-grass, wind, solar, coal CCS, plug-in hybrids and electric vehicle technologies are from *Towards a Global Climate Agreement: Synthesis Briefing Paper June 2009* (Project Catalyst 10). "Total low carbon technologies" refers to technologies considered as above in Project Catalyst (10).

$/ tCO_2e is the unit of cost of abating each tonne of CO_2e. All figures are adjusted to 2009 US$.

The reader is reminded that the estimated cost found does not take into account savings resulting from reduced populations including any reduced "burden" on social services.

[28] Data on the family planning proposal is from the findings of this project. The 2020 cost and 2030 costs have the same value because this study considers the cost over the entire period 2010 to 2050 annually on a per-person basis.

[29] Data on reduced deforestation is from the Union of Concerned Scientists' *Estimating the Cost and Potential of Reducing Emissions from Deforestation* (Boucher). The value is an average of peer reviewed global models if a 46% reduction occurs in deforestation.

The study found that some low-carbon technologies including those harnessing wind and solar energy sources are revealed as considerably less cost-effective than implementing the family planning proposal discussed. Since most technologies can be implemented within limitations of scale, it is perhaps most useful to compare the cost -effectiveness of family planning with a feasible *total* for low-carbon technologies. According to the study, such a total is almost *five times* more expensive than the family planning proposal: $25 more than family planning per abated tonne of CO_2. Achieving a reduction of 34 Gt of CO_2 would cost over $1 trillion with low carbon technologies compared to the estimated $220 billion by providing basic family planning.

The family planning proposal may change the limits and costs of implementing other technologies and vice-versa. With the family planning proposal, it is estimated that over 11 billion fewer people-years will be lived between 2010 and 2050. As a result, low-carbon technology may be required to provide significantly less energy. Therefore, all technologies and proposals in table 5.0.1 should not be viewed as independent alternatives.

6.0 DATA

This chapter provides details of the data collected and used in the study. The relevant sources are mentioned and necessary compromises are detailed.

There are many sources of data available on subjects relating to the issues in this study. As a rule, it is essential that the precise definitions used by different organisations are well recognised when comparing or combining data values. For example, data on the cost of family planning services differ greatly among different sources because slight variations in the level of family planning provided or the location at which it is provided can vary significantly. For this study, UNFPA data was used as a reliable estimate of the costs of basic family planning (Singh et al. 19).

This Project uses data from several fields of study including population levels, population growth, CO_2 emissions and family planning. As a result, no single source can provide all information. Different studies and sources provide data on regions and countries differently. Omitting countries with the lowest population levels has a negligible effect (figure 6.0.1). To account for 99% of the 6.8 billion world population in 2009, 222 countries were selected from 227 countries listed in GHC data (Daulaire et al. 42-46).

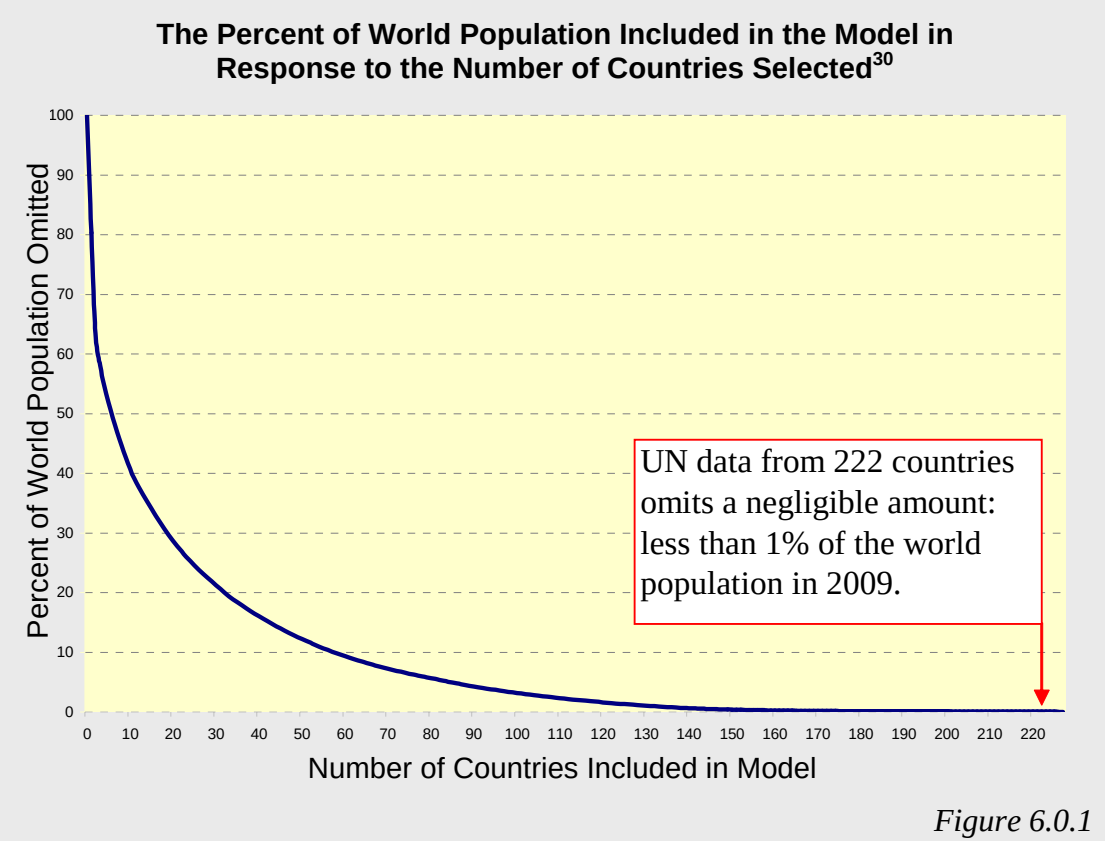

Figure 6.0.1

[30] For each data point in figure 6.0.1, the number of countries included in the model represents the use of countries with the greatest population. For example, data from 3 countries would omit around 58% of the world population (using China, India and USA).

Data source: UN Population Division.

An important part of the calculation is an estimate for unintended births. Data were available from GHC (Daulaire et al. 42-46) for the number of unintended births in each country between 1995 and 2005. Using this data, an average was taken to estimate the annual number of unintended births as a percentage of the population. In the GHC data for unintended births used in this study, unintended pregnancies exclude mistimed pregnancies and include abortions. Unintended births are estimated by the number of births multiplied by the percentage of unintended births. More information on the GHC data can be found in *Promises to Keep: The Toll of Unintended Pregnancies on Women's Lives in the Developing World* (Daulaire et al.).

UN projections of population growth rates for each country were used (UN Population Division). For each country, figures were used for five-year time periods up to 2025. Linear interpolation was used to estimate population growth rates for each country in the time period 2025 to 2045 using the UN estimated growth rates for the time period 2045 to 2050. Between every year in the time period 2025 to 2045, the population growth rate of each country changed constantly to model the difference between the growth rates of 2025 and 2045. Figure 6.0.2 illustrates the accuracy of this method when applied to global population growth rates. An example of the calculation is demonstrated in appendix B.

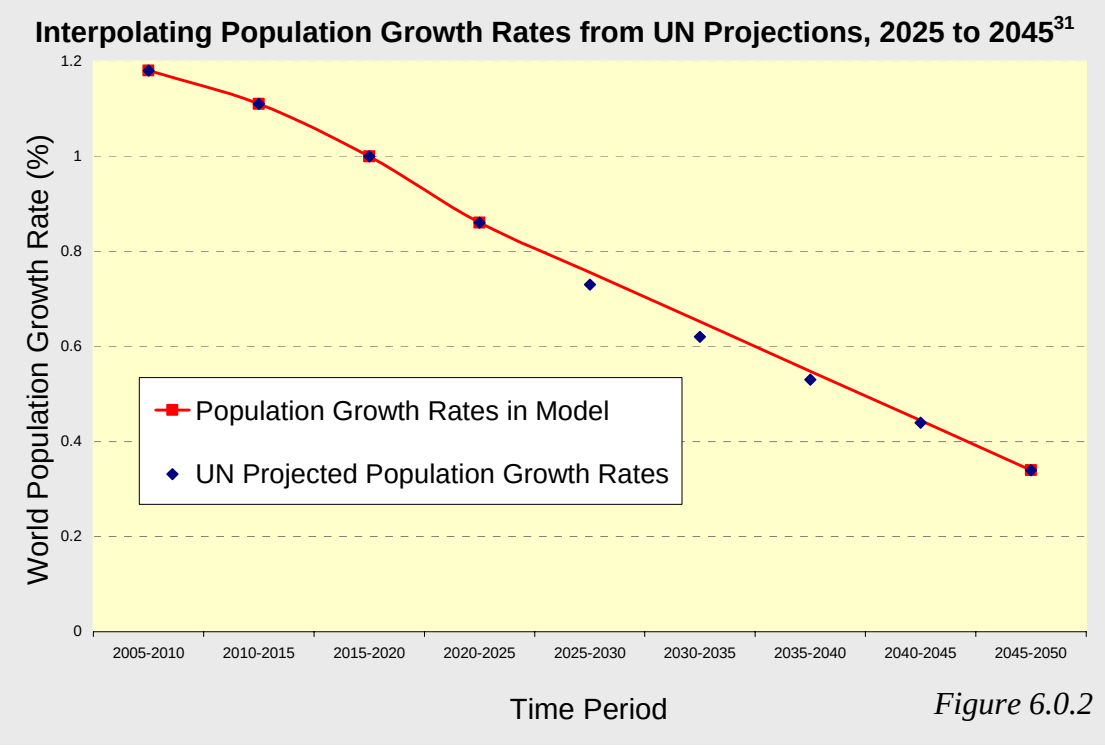

Figure 6.0.2

Some locations, with insignificant population levels relative to world population, were not identified in data on CO_2 emissions (UNSD), but contributed to the global population data (UN Population Division). Data for CO_2 emissions per capita was used from other locations. These substitutions are listed in appendix C.

The data used for emissions is for tonnes (metric tons) of CO_2 emitted per person (UNSD). Although carbon emissions are frequently mentioned in this report, the

[31] Data source: UN Population Division

figures produced refer to tonnes of CO_2 and should not be confused with the directly calculable tonnes of carbon.[32] Table 6.0.1 presents UNSD figures from selected countries.

Average Annual Carbon Emissions in Selected Countries[33]

	CO_2 emissions per capita (tonnes/ person)
Qatar	69
Kuwait	38
United States	20
United Kingdom	9
China	4
Brazil	2
India	1
Somalia	0

Table 6.0.1

In reviewing the data, the range of values is striking. Of countries with non-negligible population levels, Qatar emits the most CO_2 per capita at more than three times that of the United States. CO_2 emitted annually by Somalia is negligible at 0.00 tonnes per capita when rounded to two decimal places (UNSD). Being the only large country with negligible emissions, Somalia can be viewed as a baseline with which to view other countries.

[32] Tonnes of carbon can be calculated by dividing tonnes of CO_2 by 3.66.

[33] Data source: UNSD. Figures are rounded to nearest tonne.

7.0 CONCLUSIONS

Section 7.1 explains the context of the project in relation to carbon policy decisions. The implications are discussed and a general proposal is provided, outlining the importance of considering the CO_2 reducing potential of family planning. Section 7.2 recommends extended studies, including ideas for more accurate estimates.

7.1 Conclusions and Recommendations of the Project

The study found that CO_2 emissions can be reduced between 2010 and 2050 at a cost of around $7 per abated tonne of CO_2 emitted. If family planning meets unmet need, the study finds that such a family planning proposal can be expected to reduce CO_2 emissions by 34 Gt between 2010 and 2050. Findings assume that family planning demand is constantly proportional to population size.

Also, unmet need values consider only couples who are married or in union. The scale with which this assumption impacts the calculations is not known, but a statement by the UNFPA gives some reason to believe the assumption is significant: "[c]ommunity studies suggest that between 10 and 40 per cent of young, unmarried women have experienced unwanted pregnancy" (UNFPA 2003).

The cost/ benefit analysis found that family planning is considerably cheaper than many low carbon technologies. The study concludes that family planning is a cost effective tool in reducing carbon emissions. These findings are the result of an initial study rather than final figures to estimate precise expenses associated with reducing carbon emissions.

It can also be concluded that family planning is a worthwhile investment when we consider our finding against the IPPC's 2007 observation:

> Peer-reviewed estimates of the social cost of carbon (net economic costs of damages from climate change aggregated across the globe and discounted to the present) for 2005 have an average value of US$12 per tonne of CO2
>
> (Bernstein 69)

Based on the study's findings, it is proposed that family planning methods should be a primary tool in the optimum strategy for reducing carbon emissions. In "Managing the Health Effects of Climate Change," *The Lancet* states that "[i]gnoring high rates of population growth in parts of the world is likely to jeopardise the success of other responses to climate change and limit our ability to intervene in ways that respect and protect human rights" (Costello et al. 172).

Just as discussions on the implementation of low-carbon technologies includes economic benefits, introducing family planning as a real carbon-reducing proposal should include consideration of all social, moral and economic benefits that may be directly associated with population-growth-reduction.

7.2 Scope for Further Analyses

In order to confirm the results of this study, the findings should be clarified with different data and methods. New data may make some of the methods rejected by this study possible. If so, some of the approaches discussed in section 3.1 have merit as a starting point.

There are several ways to gain more insight into the possible effects of family planning proposals. High and low variants for population projections can be adjusted with the estimated effect of reducing unintended births to add to the calculated medium variant projections. This would demonstrate a sort of range for population projections. The costs of applying *different levels* of family planning could also be considered.

Newer data can be inputted into the model. In particular, more current values for unintended births may produce different estimates. In addition, using data from the single most recent year may be more reflective of future years, particularly if family planning implementation has improved.

It was previously mentioned in section 1.3 that potential savings from social services as a result of population-growth-reduction may be influential on family planning costs. Perhaps the most logical extension of this study would be to factor these savings into the cost estimate. To do so, a study might take average values from a number of peer reviewed global studies. Another valuable extension would estimate how much a family planning proposal would save in energy costs (even if renewable energy sources are used). This would require figures on average energy usage in different countries and the costs of providing such energy under different methods.

8.0 GLOSSARY

Definitions are provided for some technical or potentially ambiguous terms as well as variables and abbreviations. Where a citation is provided, the definition is a direct quote from the source.

Billion 10^9

CO_2e Carbon dioxide equivalent. A unit used to identify the global warming effect of greenhouse gases.

CO_2 Carbon dioxide

CO_2 tonnes Tonnes (metric tons) of Carbon Dioxide

Contraceptive Use The percentage of currently married or "in-union" women of reproductive age who are currently using any form of contraception. "Modern" methods include clinic and supply methods such as the pill, IUD, condom, and sterilization (PRB).

Crude birth rate Number of births over a given period divided by the person-years lived by the population over that period. It is expressed as number of births per 1,000 population (UN Population Division, Glossary).

Crude death rate Number of deaths over a given period divided by the person-years lived by the population over that period. It is expressed as number of deaths per 1,000 population (UN Population Division, Glossary).

GHC Global Health Council

Gt Gigatonnes or billion tonnes

Mitigation Reducing the effects of global warming by reducing the emission of greenhouse gases

Mitigation Potential In the context of this report, *mitigation potential* is the cost per tonne of CO_2 abated in comparison to current projections.

Modern Methods (of contraceptive) Contraceptive methods including "clinic and supply methods such as the pill, IUD, condom, and sterilization" (PRB).

People-Years a person-year represents the consumption of one person living on earth for one year

Population change Population increment over a period, that is, the difference between the population at the end of the period and that at the beginning of the period. (UN Population Division, Glossary)

Population growth rate Average exponential rate of growth of the population over a given period. It is calculated as ln(Pt/P0)/t where t is the length of the period. It is expressed as a percentage (UN Population Division, Glossary)

Preventable unintended births The number of unintended births that can be expected to be prevented with basic family planning (72% of all unintended births). The difference between unintended births and preventable unintended births represents the "failure rate" of family planning, partly attributable to the failure rate of contraceptives.

Rate of Natural Increase (RNI) The birth rate minus the death rate, implying the annual rate of population growth without regard for migration. Expressed as a percentage (PRB)

Tonne 1000 kilograms or metric ton

Total Fertility Rate (TFR) The average number of children a woman would have assuming that current age-specific birth rates remain constant throughout her childbearing years (usually considered to be ages 15 to 49) (PRB)

Trillion 10^{12}

UN United Nations

UNFPA United Nations Population Fund

Unintended births Number of births (calculated from population and birth rate) multiplied by percentage of unintended births (GHC)

Unintended pregnancies Unintended births + abortions (GHC)

Unintended pregnancies (percentage of) Percentage of women answering "no" to DHS survey question, "Was your last birth wanted?" Does not include mistimed births (GHC).

Unmet need Proportion of women who wish (in survey data) to delay or terminate childbearing but who are not using contraception. (Guillebaud 6)

UNSD United Nations Statistics Division

9.0 REFERENCES

Amaral, Gorette et al. "Public Savings from the Prevention of Unintended Pregnancy: A Cost Analysis of Family Planning Services in California." *Health Research and Educational Trust.* 42.5 (2007): 1960-1980.

APPG. *Return of the Population Growth Factor: Its Impact upon the Millennium Development Goals.* Report of hearings by the All Party Parliamentary Group on Population, Development and Reproductive Health. Print Management Systems, 2007.

APPG *Summary*. *Return of the Population Growth Factor: Its Impact upon the Millennium Development Goals: Report Summary.* Report of hearings by the All Party Parliamentary Group on Population, Development and Reproductive Health. Print Management Systems, 2007.

Avert. "Condoms: History, Testing, Effectiveness and Availability." Updated: 17 June 2009. Accessed: 28 June 2009. <http://www.avert.org/condoms.htm>.

Bernstein, Lenny et al. *Climate Change 2007: Synthesis Report.* Intergovernmental Panel on Climate Change, 2007.

Bligh, John. *The Fatal Inheritance*. London: Athena Press, 2004.

Boucher, Doug. *Estimating the Cost and Potential of Educing Emissions from Deforestation.* Tropical Forest and Climate Initiative, Union of Concerned Scientists, September 2008.

Chao, Dennis N. W., and Karen B. Allen. "A Cost-Benefit Analysis of Thailand's Family Planning Program." *International Family Planning Perspectives.* 10.3 (1984): 75-81.

Costello, Anthony et al. "Managing the Health Effects of Climate Change." Lancet and University College London Institute for Global Health Commission. *The Lancet.* 373. 9676 (2009): 1693-1733.

Daulaire, Nils et al. *Promises to Keep: The Toll of Unintended Pregnancies on Women's Lives in the Developing World.* Global Health Council, 2002.

Ehrlich, Paul R. *The Population Bomb*. 1968. Cutchogue: Buccaneer Books, 1995.

Ehrman, Richard. *The Power of Numbers: Why Europe Needs to Get Younger*. London: Policy Exchange and The University of Buckingham Press Ltd, 2009.

Frost, Jennifer J., Lawrence B. Finer and Athena Tapales. "The Impact of Publicly Funded Family Planning Clinic Services on Unintended Pregnancies and Government Cost Savings." *Journal of Health Care for the Poor and Underserved.* 19 (2008): 778-796.

Guillebaud, John. "Youthquake: Population, fertility and the environment in the 21st century." Optimum Population Trust, 2007. <http://www.optimumpopulation.org/Youthquake.pdf>.

Haveman, Robert H. "Benefit-Cost Analysis and Family Planning Programs." *Population and Development Review*. 2. 1 (1976): 37-64.

Hughes, D., and A. McGuire. "The Cost-Effectiveness of Family Planning Service Provision." *Journal of Public Health Medicine.* 18. 2 (1996): 189-196.

Janowitz, Barbara, and John H. Bratt. *Methods for Costing Family Planning Services.* United Nations Population Fund and Family Health International, 1994.

Kols, Adrienne. "Reducing Unmet Need for Family Planning: Evidence-Based Strategies and Approaches." United Nations Population Fund. *Outlook.* 25. 1 (2008). 1-8.

Malthus, Thomas. *An Essay on the Principles of Population.* London: John Murray, 1798.

McDougall, Rosamund & John Guillebaud. "Optimum Population Trust: Too Many People on Earth." Updated: 6 July 2009. Accessed: 9 July 2009. <http://www.optimumpopulation.org/opt.earth.html>.

Nortman, Dorothy L. et al. "A Cost-Benefit Analysis of the Mexican Social Security Administration's Family Planning Program." *Studies in Family Planning.* 17. 1 (1986): 1-6.

OPT. "Optimum Population Trust: About Us." Optimum Population Trust website. Updated: 18 June 2009. Accessed: 8 July 2009. <http://www.optimumpopulation.org/opt.aboutus.html>.

PRB. "2008 World Population Data Sheet." Population Reference Bureau. August 2008: 7-15. <http://www.prb.org/pdf08/08WPDS_Eng.pdf>.

PRB 2005. "2005 World Population Data Sheet of the Population Reference Bureau." August 2005: 6-13. <http://www.prb.org/pdf05/05WorldDataSheet_Eng.pdf>.

Project Catalyst. *Towards a Global Climate Agreement: Synthesis Briefing Paper June 2009.* Global Humanitarian Forum. ClimateWorks Foundation. June 2009.

Ringheim, Karin & James Gribble. "Expanding Contraceptive Choice: Five Promising Innovations." Population Reference Bureau, June 2009. <http://www.prb.org/pdf09/contraceptivechoice.pdf >.

Ross, John et al. *Profiles for Family Planning and Reproductive Health Programs, 116 Countries: 2nd Edition.* Futures Group. Newington: Paladin Commercial Printers, 2005.

Singh, Susheela et al. *Adding it Up: The Benefits of Investing in Sexual and Reproductive Health Care.* The Alan Guttmacher Institute and United Nations Population Fund, 2003.

Smith, Adam. *An Inquiry into the Nature and Causes of the Wealth of Nations*: *Collector's Edition.* 1776. Hamburg: Management Laboratory Press, 2008.

Smith, Rhonda et al. "Family Planning Saves Lives: Fourth Edition." Population Reference Bureau. Washington, DC, 2009.

UN Population Division. "World Population Prospects: The 2008 Revision Population Database." Updated: 11 March 2009. Accessed: 28 June 2009. <http://esa.un.org/unpp/index.asp>.

UN Population Division: Contraception. "World Contraceptive Use 2005." 1 October 2005. Accessed: 28 June 2009. <http://www.un.org/esa/population/publications/contraceptive2005/WCU2005.htm>.

UN Population Division, Glossary. "World Population Prospects: The 2008 Revision Population Database." United Nations Population Division website. Accessed: 22 July 2009. <http://esa.un.org/unpp/index.asp?panel=7>.

UNFPA. *State of World Population 2008: Reaching Common Ground: Culture, Gender and Human Rights*. <http://www.unfpa.org/swp>.

UNFPA, 2003. *State of World Population 2003: Making 1 Billion Count: Investing in Adolescents' Health and Rights.* 2003.

UNFPA *Contraceptive*. *Reducing Risks by Offering Contraceptive Services: Making Motherhood Safer.* UNFPA website. Accessed: 2 August 2009. <http://www.unfpa.org/mothers/contraceptive.htm>.

UNFPA *Family Planning*. *Family Planning: Improving reproductive Health: UNFPA.* UNFPA website. Accessed 21 July 2009. <http://www.unfpa.org/rh/planning.htm>.

UNICEF. United Nations Children's Fund. *Annual Report*, 1992.

UNSD. *Environmental Indicators: Climate Change: CO_2 Emissions*. Updated: September 2007. Accessed: 24 July 2009. <http://unstats.un.org/unsd/environment/air_co2_emissions.htm>.

Wulf, Deirder. "Cost-Benefit and Cost-Effectiveness for Family Planning Programs." *International Family Planning Perspectives*. 7. 4 (1981): 141-144.

APPENDIX A: TERMS OF REFERENCE

Sponsoring Organisation (Name & Address): Optimum Population Trust (OPT)
12 Meadowgate, Urmston
Manchester
M41 9LB

Student: Thomas Wire

Client Supervisor: Roger Martin

LSE Supervisor: Ian Lambert

Working project title (20 words max.):
A Cost/ Benefit Analysis of Reducing the Number of Additional Carbon Emitters as well as Average Per Capita Carbon Emissions

Description of problem area:
Assume that the global population growth rate can be reduced between now and 2050 so that the 2050 world population is significantly less than the United Nations' medium variant projection of 9.1 billion. It is proposed that this result is achieved by reducing or eliminating unintended pregnancies through improved access to family planning—particularly in countries with a high number of unintended pregnancies or fast growing populations. A calculated estimated is required (using official population-related sources) of how significantly the reduction in the population growth rate will reduce carbon emissions. In addition, a calculated estimate is required for the cost. Hence, this can be thought of as a cost/ benefit analysis of reducing carbon emissions through family planning.

Purpose of project:
The purpose of the cost/ benefit analysis will be to calculate a cost-per-tonne of reducing carbon emission by providing family planning services to more people globally. The results of the project can then be compared to the cost of reducing carbon emissions by other (currently more popular) methods.

If the case turns out to be as strong as at this stage seems likely, the product would be a slim A4 report, professionally published at OPT expense, for distribution to every delegation at the 2009 Copenhagen Climate Summit. OPT would also give it the widest possible circulation in the UK via the media, and targeted mailings, presentations and campaigns.

Proposed method:
After researching current studies and estimates of figures involved:

Calculate 'benefit':

(1) Use reliable estimate (or calculate estimate) for the number of unintended births globally by country or region

(2) Assume that the above cases can be virtually eradicated by sufficient family planning services

(3) Estimate the effect that such a level of family planning will have on the population growth rate in all countries
(4) Project estimates for each year from now to 2050 assuming unintended pregnancies are avoided
(5) Compare the above estimates to current projections
(6) Use reliable estimates (or calculate estimates) for carbon-tonnes-emitted per capita in each country/region (from households and infrastructure) and calculate the number of carbon-tonnes emitted with, and without, the proposal
(7) Calculate the reduction in carbon emissions globally
(8) Draw attention to the possibility that demand for family planning may actually be stimulated in reality by referencing the most successful non-coercive programmes (i.e. in Thailand or Iran). If possible factor this into the figure from (7).
(9) Draw attention to additional reductions in carbon emissions from reduced forest-clearing and agriculture. If possible factor this into the figure from (7).
(10) Draw attention to all other benefits of reducing population growth.

Calculate 'cost':

(1) Estimate the number of people that would need to be provided family planning services to assume the above benefits are achieved
(2) Calculate the total cost
(3) Calculate the cost of supplying renewable energy to the additional consumers who will exist in the absence of such measures

Calculate Cost/Benefit of Investment in Fewer Births

Derive from the above the total money cost, the total carbon-tonne saving, and hence the cost/benefit ratio expressed in cost per carbon tonne saved, of each unwanted birth prevented.

Calculate Cost/Benefit of Conventional Alternative

Using aggregate figures for standard energy saving, fuel efficiency, and new technology investment, derive a standard cost per carbon tonne saved by the conventional means currently under discussion in preparations for the Copenhagen Summit.

Data type and sources:

Relevant and current data published by any of the following:

- All Party Parliamentary Group on Population, Development and Reproductive Health
- Global Health Council
- Optimum Population Trust
- United Nations Populations Fund
- Population Reference Bureau
- Other official or reliable sources as necessary

Hardware and software required and available:

- Spreadsheet software (e.g. Microsoft Excel) accessed from home/ LSE
- Internet accessed from home/ LSE

- Statistical software (e.g. Minitab) accessed from LSE

Deliverables:
A slim A4 report for distribution to every delegation at Copenhagen. The headline claim would be on the cover, with an appropriate illustration, and a one-page summary as the first page.

Agreed by:	Internal supervisor	Date
	LSE supervisor	Date
	Student	Date

APPENDIX B: TECHNICAL EXPLANATIONS

This appendix includes a technical explanation of several calculations made during the study. All sections of this appendix are referred to within the chapters of the report.

Linear Interpolation for Population Growth Projections

Linear interpolation was used to estimate population growth rates in the time period 2025 to 2045. The population growth rates for Afghanistan (the first country in our alphabetised list) are used to illustrate this process. The projected population growth rate in 2025 is 2.55% as it is used for all years 2020 to 2025. The projected population growth rate in 2045 is 1.63% as it is used for all years 2045 to 2050. From 2025 to 2045 is 20 years ('steps') that, by linear interpolation, we consider each year to have an equal change in projected population growth (in this case, decrease). This change is calculated by:

$$\frac{(1.63 - 2.55)}{20} = -0.046$$

So, for example, the 2026 projected population growth rate used for Afghanistan is:

$$2.55 - 0.046 = 2.504\%$$

Calculating Projected Populations from Growth Rates

By the UN Population Division's definition of 'population growth rate' (glossary), over a one year period:

$$\text{Population growth rate} = \ln\left(\frac{P_t}{P_0}\right)$$

Where P_t is population level at the end of the year and P_0 is population level at the beginning of the year. Using Afghanistan as an example, the 2009 population is given as 28,150,000. Therefore, given that the population growth rate used in this period is 3.45%, we can calculate 2010 projected population:

$$\text{2010 projected population of Afghanistan} = 28{,}150{,}000 \times e^{0.0345} = 29{,}138{,}122$$

Finding Growth Rate with *Family Planning Proposal*

Afghanistan is again used an example. An estimate for 2010 population level with the family planning proposal was estimated by reducing 2010 projected population level (29,138,000) by 72% of average annual unintended births (116,179).

Projected Afghanistan 2010 population level with the family planning proposal =
29,138,000 – 116,179 =
29,021,821

Recall that Afghanistan's 2009 population is given as 28,150,000. A population increase to 29,021,821 represents a population growth rate of 3.05% (using formula

defining population growth rate). The current projection for population growth rate in Afghanistan is 3.45%—a difference of 0.4. On this basis, it was assumed that all projected growth rates for Afghanistan are reduced by 0.4 and population levels could be estimated accordingly.

Calculating the Cost-Benefit

The total cost of the proposal is $220,160,067,240 to prevent an additional 34,070,902,000 tonnes of CO_2 being emitted. Therefore:

$$\text{Cost of preventing each tonne of } CO_2 \text{ emitted} = \frac{220,160,067,240}{34,070,902,000} = \$6.46$$

Assumptions in Analysis

The assumptions below were made for the purposes of analysis in this project. Some assumptions are necessary to dictate the reliability of the estimated mitigation potential. Other assumptions are less essential in that they are used more to determine the limits of the proposal. It was assumed that:

- The CO_2 emissions per-capita of certain smaller countries/ regions can be approximated by other countries as listed in appendix C
- The average number of annual unintended births from 1995 to 2000 is representative proportionally of the number of unintended births in the future
- Demand for family planning will represent a constant proportion of each country according to each country's current unmet need i.e. demand for family planning will not significantly change in the time period 2010 to 2050 proportional to population size
- Meeting unmet need will reduce unintended births by 72% as predicted by UNFPA study (Singh et al. 20)
- Population growth rates in all countries will be linear, as approximately projected by data (UN Population Division)
- Family planning costs per person with unmet need will be linear within the range of unmet needs dealt with annually (from about 200 million per year up to a projected 250 million per year)
- Average CO_2 emissions per capita will remain constant for each country
- The per-capita-cost of providing family planning will be equal in all countries

ANNEX: OPT STATEMENT ON CLIMATE CHANGE

"Family planning could bring more benefits to more people at less cost than any other single technology now available to the human race." (UNICEF Report 1992)

Population Growth and Climate Change

Statement by the Optimum Population Trust

1. Background Facts

All environmental problems, and notably those arising from climate change, would be easier to solve with a smaller future population. Population restraint in rich countries and communities would reduce the future number of major carbon emitters (who will also be victims). Restraint in poor countries and communities would reduce the number of minor emitters and likely major victims.

The gap between the extremes of the UN (2008) population projections for 2050 is 3 billion people. Current trends, with less aid for family planning, point towards the higher end - 11 bn, with no change in fertility (the UN median projection, at 9.2 bn, assumes a considerable reduction in fertility). Just meeting known, but currently unmet, need for family planning services, however, would point the projections near the lower end - 8 bn.

The recent Global Humanitarian Forum on the Human Impact of Climate Change in Geneva accepted OPT's position that population growth is a major environmental problem, making equitable mitigation and adaptation policies harder – and ultimately impossible – to solve.

2. OPT recommends that climate change negotiators:

a) recognise that population restraint is a necessary, though not sufficient, condition for the solution of the problems caused by climate change;
b) accept the need for **all** countries to adopt non-coercive population policies;
c) accept programmes to implement such policies in poorer countries as legitimate candidates for climate change funding;
d) give immediate priority to meeting the existing unmet demand for family reproductive health care in the poorest countries;
e) recognise that programmes educating and empowering women to control their own fertility are also essential for the success of population restraint programmes;
f) take account of the major humanitarian benefit of lower fertility in relieving the suffering of many of the poorest women and children in the world.

3. OPT also <u>recommends</u>:

That the principle of "contraction and convergence" (rich and poor converging towards a common per person emissions target) be accepted as an equitable starting point for distributing total tolerable carbon emissions, provided that this is allocated to states on the basis of their population size at a specific date. This would encourage the adoption of population restraint policies; whereas allocation on a simple per person criterion would encourage continued population growth, thus continuously reducing every person's carbon entitlement.

<u>Statement endorsed by</u>

Sir David Attenborough, *Naturalist, broadcaster and wildlife film-maker**

Professor Sir Partha Dasgupta, *Frank Ramsey professor of economics, University of Cambridge**

Professor Paul Ehrlich, *Professor of population studies, Stanford University**

Professor John Guillebaud, *Emeritus professor of family planning and reproductive health, University College, London**

Susan Hampshire, *Actor and population campaigner**

James Lovelock, *Gaia scientist and author*

Professor Aubrey Manning, *President of the Wildlife Trusts; emeritus professor of natural history, University of Edinburgh**

Professor Norman Myers, *Visiting Fellow, Green College, Oxford University**

Sara Parkin, *Founder director and trustee, Forum for the Future**

Jonathon Porritt, *Founder director, Forum for the Future; former chairman, UK Sustainable Development Commission******

Professor Chris Rapley, *Former director, the British Antarctic Survey*

**OPT patron*