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Toxic Omissions and Cancerous Growths: Addressing the Unexamined Assumption of Sustainable Consumption in Technologically Innovative Societies

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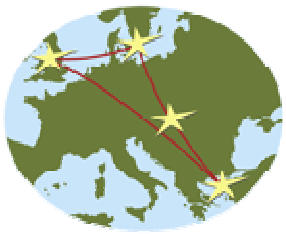

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Abstract

This study challenges existing dogma of economists and environmentalists with a finding that sustainable consumption in industrial societies is impossible within standard models of growth because the approaches that are being taken to investments (in new technologies) are linked with and dependent on increased consumption as a requirement of innovation and as part of ideology in societies. Though slight reductions of resource consumption are being reported in some societies that have high environmental standards, existing high levels of consumption in these industrial societies still continue to overshoot the biocapacity of the earth and technological policies are linked with the cause of the problem rather than with the solution. This speed and rate of reductions in consumption that new technologies bring is not sufficient to ensure the possibility of sustainability on the planet. These countries are locked into a situation that cannot be changed because certain ideologies of "infinite" economic growth coupled with the realities of current production practices and political choices currently prevent it to do so.

The study examines existing international data, offers a case study of innovation-consumption in Sweden and Denmark, offers thought experiments on social change pathways, and presents a preliminary model of a sustainable technological society.

A radical change in thinking and in policy approaches appears to be needed in order to continue technological advances within the biocapacity of the earth (and accessible near-earth resources). The author offers policy recommendations to governments to replace Ministries of Trade and generate new planning agencies and systems of measuring links between technology and consumption. It also advises researchers, non-governmental organisations, civil society and social thinkers to reorient ideologies and the goals of society and technology towards uneconomic motivations; a major global culture change, different from the approaches currently offered by those who call for "sustainable growth" or even "sustainable development".

Executive Summary

While other studies have begun with an untested assumption that technologies are part of the solutions to the current global environmental degradation and can be used to minimize consumption, this study examines the relationships between technology and consumption, and technology and production to test that assumption, by modeling relationships between consumption and technological innovation. Other key factors included in the model tested are life satisfaction, life expectancy and social equity.

The **problem** that the study tries to address is that there exists an apparent incompatibility of sustainable consumption and technological progress in industrial societies. The paradox of science and technological progress in contributing to human progress and curtailing environmental degradation and resource depletion is most noticeable in technological societies.

The study examines whether sustainable consumption in technologically innovative societies is possible, and if so, at what cost to equity and to humanistic development and satisfaction by looking at patterns of development of existing and extinct societies, and developing a test model for social change that would achieve sustainability in a technological society. The approach to modeling is one of thought experiments to explore the paths of development that industrial societies are following and to briefly test the hypothetical paths that can be generated as models of potential change towards sustainability against existing historical examples. A preliminary hypothesis reached from this study is whether there are multiple paths or whether there is a single and constrained path that prevents full human development within the ecological limits in human societies.

The **purpose and objective** of the study is to find the optimal path to sustainability in technological societies. The aim of the study is to contribute to the understanding of the relationships between technological innovations and resource demands in the complex matrix of dependable cultural features and various qualities of sustainability in an industrial society. Never before there be a model developed that reflects the existing patterns of development and predicts the dynamics and trajectories of these patterns in technological societies with respect to resource consumption and innovation. Therefore the major aim of this research is to develop models of the "best" cases or "ideal" types of sustainable technological societies, both existing and imagined, with policy suggestions on how to maintain or achieve these.

In a search of the environmental policy **literature**, the environmental economics literature, and some work in related social sciences, there is no existing scientific theory in the area of consumption, technological change and sustainability to be proven or disproven by the research and no specific models by authors that this researcher has been able to find. What the literature contains are several untested assumptions that then form the basis of other work. The literature review is therefore a survey of different "philosophies" that underlie various disciplines touching on the questions of productivity, innovation, sustainability, and the "good society." These range from ecological perspective, psychological works, and cultural analysis to economics theories and technological innovation theories. To discover the factors influencing individual and collective choices and preferences, the study examines a wide range of cross-disciplinary research works offering various theories on how social preferences are determined and influenced in certain environmental contexts, capturing the most relevant discussions regarding to consumption and production.

This study employed a wide range of **methods** to identify factors determining societal patterns of development and to develop hypothetical models of such patterns. This study firstly carried out an examination of the range of societies that exist and their current choices by using static analysis of the patterns. The examination of the data was also used to suggest whether or not there are "paths" of development, the counties in which preferences can move along a path; and if so, how many different paths there may be. This was done by using dynamic analysis, suggesting a time dimension.

- The study uses data from United Nations database, Global Footprint Network, New Economics Foundation, Global Innovation Scoreboard, OECD statistics and other national statistics sources, asking questions of the data that other researchers have ignored.

- International data are used to preliminarily explore the linkages between consumption, innovation and social preferences by quantitative modeling. Static and dynamic "patterns" or "paths" of choices are examined to understand the linkages and correlations between these factors and variables. The static model using current international data reveals five patterns of societal choices for existing societies. When placed in a dynamic model accompanied with a historical perspective, there are at least eight archetypal paths of development that are identified in the study for extinct, existing and visionary ideal societies.

- The theoretical models are then tested for comparison of choice in Sweden and Denmark, two societies in similar environments.

Using the method of thought experiments and path analysis of social choice, this study suggests that in order for a society to be able to move towards the ideal type, eliminating military industry and transforming the war economy into peace economy would significantly reduce the high levels of consumption in industrial societies. The constraints to a transition for industrial societies may include their current ideology of infinite economic growth and the long-lasting assumption and belief in a positive correlation between increased income and life satisfaction, as well as the current political choices amongst political parties.

The discussion that this study brings about is a discussion on a model for transition to the "ideal" innovative society. Innovative capacity of individuals and cultures cannot be best measured as their capacity to economically outperform others as the current innovation indices do now, but rather be measured by their ability to use their innovativeness to reach culturally tailored sustainability.

The principal **finding** of the study is that **sustainable consumption in industrial societies is impossible within standard models of growth because the approaches that are being taken to investments in growth (in new technologies) are linked with and dependent on increased consumption as a requirement of innovation and as part of ideology in society. Industrial countries are locked into a situation that may be able to change but certain ideologies of continued and "infinite" economic growth in the realities of production and of the political choices currently prevent them to do so**.

From analysing the various sets of international data, the study has identified four main patterns of development for existing societies, two for other societies that exist but are not included in the database of the study, one pattern of the extinct empires and the "visionary ideal" archetype of society.

- Pattern 1 – Hollow development: High innovation performance, high levels of consumption, high satisfaction with life, least disparity in income contribution, and high average life expectancy;
- Pattern 2 – Traditional stagnant: Low innovation performance, low levels of consumption, high disparity in income/ wealth distribution; medium long lives, and dissatisfaction with life;
- Pattern 3 – Exploring or Receding: Medium innovation performance, medium levels of consumption, low or medium low disparity in income/ wealth distribution, medium or good long lives; quite satisfied with life;
- Pattern 4 – Explosive consumptive: High innovation performance, extreme high levels of consumption, high disparity in income/ wealth distribution; high average life expectancy and satisfaction with life;
- Pattern 5 – Traditional egalitarian: Low innovation performance, low levels of consumption, low disparity in income/ wealth distribution, medium long lives and satisfaction with life;
- Pattern 6 – Unstable empires (ancient civilizations, extinct – and this is the phase 2 of the pattern 4 societies): High innovation performance, extreme high level of consumption, high disparity of wealth distribution, short life expectancy and satisfaction with life;
- Pattern 7 – Visionary ideal (non-existence on planet Earth in 21st century): High innovation performance, sustainable levels of consumption, equity in income/wealth distribution, good and long lives, and satisfied with life; and
- Pattern 8 – Crisis kingdom (not in the database but existent in reality, e.g. Myanmar, Zaire, Haiti): Low innovation performance, low/ high levels of consumption, high disparity of wealth distribution, short life expectancy and dissatisfaction with life.

For the testing of hypotheses for Denmark and Sweden, the main findings are below:

- Statically, the two societies appear to have very similar choices with regard to social preferences, i.e. welfare benefits and social policies in a universal welfare state model (which reflects in decisions on ensuring a least disparity in income and wealth distribution, a high level of satisfaction with life and good health conditions as a basis for high average life expectancy).
- The two societies also have rather similar perspectives toward the roles of innovations toward sustainability – an emphasis on economic motivations for technological innovations. Although there appears a small divergence in the dynamics and trajectories of development between these two societies, whether

these two societies are diverging into two different paths toward development is not addressed yet in this study.

- Technology-dependent economies require high concentration of resources not only because increased consumption is a requirement for continuous innovations but also due to increasing trade activities.

- Internationalization of innovations under the globalization scenario reinforces the positive feed back loop of innovation and consumption.

- Market orientation of innovation policy may hamper sustainability solutions.

- Military industry that is competing for competitive advantages in exporting war material is actually a player that would keep consumption increasing.

The study offers the following **recommendations** for research and policy with regard to "gearing" societies toward "Good" Societies.

- **Mission Changes for Governments:** Given that sustainable consumption in technologically innovative societies is possible only when technological development is directed toward planned consumption and production, governments need to measure the levels of consumption (Gross Domestic Consumption) against their national resource base (reflected in the national balance sheet) rather than seeking ways to measure how much the country can produce more effectively and efficiently. Competition for a market niche and increased market share in the global marketplace cannot be an appropriate method to seek for a best technological solution to deal with the overconsumption problem and resource depletion. Ministries and national agencies that promote trade should be replaced by another planning agencies that approach to promote innovations and technologies on the basis of balancing national assets rather than seeking out resources outside the national boundaries to meet domestic needs and boost infinite growth. There is also a need to have a Gross Domestic Consumption (GDC) and to start using it in place of Gross Domestic Product (GDP) to monitor and measure national asset balance.

- **An Expanded Agenda for Environmental Economists:** A different direction of research needs to be done with the economic equation of Gross Domestic Product (GDP) in which an increase in other "investment" would be factored in the equation to make the society better off in the future, not only increase in private consumption. Further research also needs to be done in the areas of national security and global threats to national security with regard to resource exploitation both from multinational corporations and military aggressive agents and within national powerful parties and organisations. The correlations between consumption and other factors such as life expectancy and broader defined innovation also need to be further studied.

Table of Contents

List of Figures

List of Tables

1 Introduction

1.1 Problem statement: The Apparent Incompatibility of Sustainable Consumption and Technological Progress in Industrial Societies

The long-neglected factor in the consumption-production equation within the environmental limits is the value of social investment for future benefits and human development, an increase of which has an equal impact as does consumption factor to changes in Gross Domestic Product (GDP) that has been widely criticized as a false measure of human well-being and humankind progress. In sustainability discourse, the focus has been shifted in between two sides of the equation, namely consumption and production, without further understanding about how choices are collectively made in a society and without any attempts to explain the existing paths of development that modern societies, their trajectories and how societies would make a better choice in terms of sustainability. Choices that a society would make over its priority list of what to be invested are however largely ignored, thus merit further study.

The paradox of science and technological progress is a modern phenomenon in our time when most of achievements in human progress have been made possible thanks to scientific and technological improvements and at the same time when the scale and magnitude of the current environmental problems is caused largely by the same source of progress – technologies are the source and origin of sustainability deficit. Adding more to that, developed countries are now facing a dilemma in which despite of increasing economic growth (GDP per capita), people are not getting happier or their standard of living is no longer improved (Ayres, 1996). For less developed countries, a dilemma that are being faced is however that the further they are "forced" to integrate into the globalization process and free trade market, the more they would need to develop their technological capacities in a certain biased technologies as a self-defense method since they have reasons to fear of their resources eaten up quickly by others.

For the current environmental problems, it is the scale, the magnitude and the dimension of environmental problems that are basically the concern. It is both the physical scale and the scale of a broader social implication (National Academy of Engineering, 1996). But from the sustainability perspective in the history of human civilization, the sustainability question of a society has not been only something to do with the scale of its impacts on its environment and resources, as Jared Diamond (1992, 1994) in his *Collapse* has suggested: the relationship between ancient peoples and their natural environments were not generally sustainable. Then the question now becomes as to whether modern societies with technologies would be viable in the long run?

Although the issue of sustainable production and consumption has gradually entered policy agenda of governments and international organisations, and has been promoted by a wide-range of multi-disciplinary research institutes and non-governmental organisations (NGOs), the focus of efforts has been on changing unsustainable patterns of production and consumption, and on producing and consuming *differently*, rather than on producing and consuming *less,* overall. The crude message from the debates on Sustainable Consumption and Production seems that developing countries still need to consume *more* and developed countries need to consume *differently*, only. Initiatives of "producing and consuming differently" like adoption of eco-efficiency improvements and greening markets from the production side, and advocacy of green consumerism and service sharing systems on the consumption side, are in fact insignificant in reducing the destructive aggregate environmental impacts of increasing consumption (Alfredsson, 2004). Technological efficiency gains are not currently able to catch up with increasing resource consumption (Durning, 1992; Mont &

Plepys, 2007; Wackernagel & Rees, 1996), not driven only by consumerism lifestyles but also by imbedded preferences of choice of people towards a desired society. These merely postpone a problem of global overconsumption of resources rather than seek to resolve the real underlying problem of "over"-consumption; the problem of consumption, itself, and create a false sense of complacency. The United Nations Environment Programme (UNEP) states the problem succinctly: Governments and international organisations define "sustainable consumption" as "consuming differently, consuming efficiently, but not consuming less" (UNEP/ CDG, 2000). This stand on sustainable production and consumption debates has a root in an untested presumption that technological progress would bring about sufficient improvement of resource and energy efficiency and productivity to maintain the current levels of consumption of industrial countries without jeopardizing its sustainability. Thus, so far, technological subsistence – technology considered as the major factor of consumption change, appears to be a choice widely accepted in the mainstream agenda of sustainable production and consumption.

Even when consumption patterns are largely advocated to be subject for change in order to achieve sustainability, societies face the problem of determining sustainable consumption patterns and sufficient levels (Brown & Cameron, 2000). Most policies on sustainable consumption and production seem to avoid the question of which levels of consumption (and production) are sustainable, but only focus on the patterns of consumption (look up at all the programmes and frameworks put forward by OECD, UNEP, UNDESA, UNCHS, etc. from 1995-2003 in (Fuchs & Lorek, 2005). The question has been partly avoided due to the fact that it is difficult to define a sufficient level of consumption as a collective decision determined to achieve full human development.

There are however few studies on the dynamics and patterns of **collective** behaviours of a society or culture and the impact of consumption choices on the survival and progress of a society. There have been an increasing number of multi-disciplinary research studies of patterns of consumer behaviours from economic, psychological, cultural and ecological perspectives, but only from individual behaviours. Policy-oriented studies have also looked at behaviour patterns and responses at the level of individuals and their implications for policies of sustainable consumption. However, collective choices are all about social decisions and choices towards collective goods that are defined broadly covering all natural resources and ecological services that are vital for the subsistence of life on Earth. Public policies on how to sustainably use natural resources and what responses a society should make to react to a changing environment reflect and shape collective choices over time.

There are few research works on other models of consumption in relation to various qualities of sustainability that a society wants to achieve (there are so far MacNeef's model of consumption (GDP growth) and human well-being, and the New Economics Foundation (NEF)'s work examining the relationship between ecological footprint and quality of life.) There is a need to develop models that take other aspects of sustainability into consideration, while understanding how to reduce resource consumption coupled with the need to maintain a high quality of life in an innovative and creative society.

1.2 Purpose and objective: Finding the optimal path to sustainability in technological societies

The purpose of this study is to understand the relationship between different factors and variables that determine and have influence on patterns and levels of resource consumption in industrial societies. The factors contributing to the levels of resource consumption in the complex matrix of dependable cultural features and various qualities of sustainability in a society are also a significant and important goal for this study.

The study aims to:

- Develop a theoretical model that reflects the interactions among consumption level, social equality and innovation;
- Identify possible factors contributing to a society that attains social equality, high innovativeness and sustainable resource consumption.
- Develop models of the "best" cases or "ideal types" of sustainable technological societies, both existing and imaginary, with policy suggestions on how to maintain or achieve these.

1.3 Research questions

The primary question of this study is:

> **Is sustainable consumption of resources possible in a technologically innovative society; if so, how can it be achieved and at what cost to equity, humanistic development and satisfaction?**

The question is significantly different to the questions frequently asked in previous studies on sustainable consumption and production, and sustainability in various ways. The question deals with the rebound effects of re-consuming efficiency gains, the challenge of changing consumption patterns and untying consumer lock-ins; all of which are perceived as challenging for organisational and system changes. For the rebound effects of re-consuming efficiency gains achieved by scientific and technological progress, the current research tackles the issue with a reverse approach regarding the relationship between technical improvement, consumer behaviours and consumer psychology. Widely acknowledged explanation for the rebound effects is on consumer psychological response as a result of individuals maximizing either utility of goods and services or their comfort and convenience (deliberately or not) or maximizing both. The question of this study is really a question as to whether increasing consumption is the stimuli for technological progress and vice versa; whether technological improvements lock our society in the "only" choice of increasing production and consumption or free ourselves from the vicious circle of materialistic consumption.

For resource economists, the question can be posed in the standard formulas and equations that are used by economists in examining government accounts. Prior to the work of environmental economists, most economists simply measured progress on the basis of increased production and consumption, viewing both as goals to be maximized. They wrongly assumed that there were no constraints on resources and avoided the kind of accounting that all businesses use as measures of their sustainability; the need to increase their total "assets" as a measure of wealth and not just to increase production and consumption (income) while their assets (and public assets to which they were given access or license to exploit without having to compensate their value) were depleted. Resource economists have now sought to bring traditional economists into the real world by placing simplistic income and consumption measures within the framework of national "balance sheets" such that increased "national income" ("Y") actually increases or maintains total national assets, including national resources and other forms of productive and consumptive values.

The standard equation that economists have used to measure "national income" ("Y") contains measures of private "consumption" ("C"), "public and private investment" ("I"), and "public/ government expenditure" ("G") that resource economists have been supplementing with resource depletion and depreciation measures in the framework of national balance sheets. However, there has still been little effort by (environmental) economists to ask more

fundamental questions about whether public and private investment can reduce private consumption in ways that will allow reaching a sustainable balance of a country's resource base.

This study takes the simplistic equation that economists have used:

$$Y = C + G + I$$

It asks fundamental questions about the different kinds and segments of private and public consumption (C and G) and the relationships that exist between different kinds of investments to achieve innovations and efficiency, with these different kinds of consumption.

In fact, aggregate private consumption, "C", really consists of three different kinds of aggregate consumption: Consumption for basic needs of an individual ("$C_{Maintenance}$"); consumption for enjoyment and recreation ("$C_{Enjoyment}$"); and consumption for extending life and health ("$C_{Life\ extension}$"). Each of these forms of aggregate consumption consists of a demand component and an efficiency factor, and is also dependent on population to calculate the aggregate.

$$C = C_{Maintenance} + C_{Enjoyment} + C_{Life\ extension}$$

Similarly, investments can parallel these categories. Aggregate investment, "I", includes existing productive investments to maintain current outputs in existing technology ("I_M"), as well as investments in research and development ("innovation") that can either generate new products to meet new needs or can reduce overall consumption in different categories by increasing efficiencies. Some of the various segments of investment can be represented as follows.

$$I = I_M + (Ie_{Maintenance} + Ie_{Enjoyment} + Ie_{Life\ extension})$$

in which $I_{INNOVATION} = (Ie_{Maintenance} + Ie_{Enjoyment} + Ie_{Life\ extension})$

The question that is new in this thesis is not only about the choices that different industrial societies make in these different consumption and investment categories, but about the relationships that exist between the different subcategories and whether those relationships actually prevent balancing of the equation. Among the key questions, for example, are whether consumption for enjoyment and recreation ("$C_{Enjoyment}$") is a function of investment spending for different productive efficiencies.

$$C_{Enjoyment} = f(I_{Innovation})?$$

In other words, "Do workers and the public in an industrial society need to be compensated with particular amounts of recreational consumption in order to be induced to innovate?" Is the factor, f, smaller than the efficiency benefit, or does the attempt at innovation simply throw the national account balance sheet into disequilibria?

Assuming that behavioral incentives are not fixed, this question is also about choices of values and trade-offs, if any ever there are such trade-offs, that a certain society would have to make when weighing being innovative, technologically, in order to increase chances for humanity to be viable as a species in the universe, with other goals for humanistic development in order for humanity to be equally viable as a happy species on the Earth. To the extent of examining the role of science and technological progress in contributing to a viable and sustainable human society, the research question of this study is somewhat close to the question that Robert

Ayres (1996) asked in one of his works: "To what extent is increasing human welfare attributable to science and technological progress rather than to economic growth" (Ayres, 1996)?

The answers to the following sub-questions questions would help shed light on the main research question:

- Is there a unique "path" of development for all industrial societies? If so, how does this "path" look like?

- What are the possible contributing factors, in the context of sustainability, to the increase of resource consumption in technological societies?

- What factors can possibly be changed without jeopardizing a "reasonable" – that is, difficult to define - level of continued technological growth?

Note that there are also different opinions on what the necessary or reasonable level or "sustainable" level of technological growth is that allows a society to be continually innovative and that will be at a rate sufficient to protect human civilization from the possible sources of NON-human threats to live on the planet and/ or to future spread of humans off the planet. This rate does not yet seem to have been estimated by scientists though there are predictions that viable independent human civilizations need to be established off the planet within the next 10,000 years. The "reasonable" level of technological growth may be the level at which the aggregate material and energy throughputs generated by societies as induced by technologies stay within the "safe zone" that does not reach beyond threshold point or spectrum that leads to a breakdown of the eco-systems? But whether this "reasonable" level of technological growth, as speculated here, is sufficient enough for human civilization to increase its chances of being viable on the planet?

- [What are the potential kinds of societies possible with technological growth which allows for experimentation and diversity of human innovations in other spheres than technology and what are their resource needs?]

This question is speculative and may not be answered in the context of this study, but it is important to keep in mind that the goal of human development that this study takes as an assumption of quality of life and existence is not just sustainability in a singular form of existence, but a full expression of human potential and choice.

An important question that this paper will not address since it is outside the scope but that should be taken into consideration is the following. Most of the ecologically sustainable societies on earth are societies with low levels of technology and who are threatened by the societies that are the focus of this study – those that are developing new technology. By a consistent definition of "sustainability", the "ecologically sustainable societies" are not, in fact, ultimately sustainable since the earth has a limited lifespan and is also subject to increasing risks, both of human and non-human origin. Human societies will ultimately have to leave the earth and exist elsewhere or in complex linkages of planetary or artificially created environments. The question of preserving these low technology societies is NOT only a moral one but may also be linked fundamentally with the sustainability of technological societies since the human value of protecting human cultural diversity and the right of human choice may be essential to the survival of technologically developed and advancing societies. This paper will focus on the technologically developing societies but does not neglect the importance of non-technological societies and their rights, as well as their existence as models of sustainability, though they are not "sustainable" in the strict definition of the word.

1.4 Scope and limitations

1.4.1 Scope: The first small step on a new field of enquiry

The research question of this thesis is, admittedly, a question not only big enough for a doctoral dissertation, but really that of a lifetime of work, and more that can probably be answered by one person. The goal of this thesis is to begin framing the research and to answer some preliminary questions with some data that can point the way to future work and more definitive answers.

The theoretical model is developed based on secondary data for twenty-five countries covering four continents. These are the countries whose capacities on innovation, or economic competitiveness are indexed by the Global Innovation Scoreboard. They include highly industrialized countries in Northern Europe, North America, Asia-Pacific and other industrializing countries in Asia, Latin America and Africa. Social equality, quality of life and consumption levels of these countries together with their technological innovation performance are also covered in this study. To a limited attempt, other forms of human expressions and creativity are also touched upon in the analysis and discussion.

Although the time dimension is important for this type of study focusing on identifying and coding development "paths", patterns of social choices and social preferences, this study covers only the current time, ten-fifteen years, for the data analysis. But the vision of sustainability of humankind on earth, which is the major concern in this study, is for 10,000 years.

For the case studies, testing the model and hypotheses, the study is focused on Sweden and Denmark.

1.4.2 Data limitations

Given the breadth of the question asked in this research and the early and rough data sets that are available to reach to some answers, part of the approach of this thesis is the application of scientific "intuition" to very rough data. In undeveloped scientific fields, such intuition in looking for ways to better specify relationships and data is part of the process of opening the field to more specific, "scientific" examinations that may follow.

The examination of the data in developing models of interactions among different factors - In the dynamic analysis for a time dimension suggestion of development "paths", data has not been collected or processed yet for historical analysis and it is only possible to make suggestive interpretations of trajectories of social choices over time.

All the indicators and measures that are used to develop theoretical models in this study are developed by scholars from developed and industrialized countries. This reality may limit the extent to which the tools are well reflecting the cultural and ideological differences.

Countries selected to develop models: only twenty-five countries whose global innovation performance is indexed by the Global Innovation Scoreboard. While data for other factors such as Ecological Footprint, Gini coefficients are available for many more countries and territories, in order to have data for ALL factors and indicators in order to limit the reports of missing data, only twenty-five countries are selected in this research.

Field research: Only physical information about schools in Denmark was collected during site visits. Companies and schools in Sweden are only in Lund, southern Sweden.

1.5 Methodology

A literature review and analysis was done partly to look for theories on individual and social choice of which the relevant applications would be used in developing theoretical models reflecting causality of relations between technological innovations, life satisfaction, life expectancy, social equity and resource consumption. The review of the previous works in the field of sustainable consumption and production and relevant associating fields is also aimed at identifying what has not been done in the topic area.

The approaches to this work included: quantitative analysis of existing multi-country data-sets using some preliminary variables to look for general relationships between certain factors; qualitative case studies to go beyond the general data and to seek to better define variables and relationships that are hidden by the preliminary variables; and "thought experiments" to test potential complex relationships and pathways of social change.

The quantitative analysis is described in section 1.6 and within the text, in examining the findings. The statistical tools that were used include regression analysis, cluster analysis, simple correlations, and data inspections for preparing the data sets.

The qualitative method was mainly employed in this study since the study tries to understand "why" and to identify the factors that contribute to the high levels of consumption in industrial countries as well as to suggest any possibilities that would change the current seemingly embedded paths of development. Understandings gained by applying critical path analysis and thought experiment were used to develop theoretical models which were applied in analysing case studies. This was done partly through in-depth discussions with researchers and teachers at research institutes and universities (Technology, Sociology, Psychology and Economics), and innovation managers with engineering and/ or economic background at companies (technical departments) in Sweden and Denmark. Cluster analysis; regression; correlation coefficients; and multi factor analysis are the quantitative methods that are used to draw the correlation between different factors in the models.

Testing theoretical models in similar environments (Sweden and Denmark): Thought experiment (Interview; talks) and path analysis, and different sources of evidence (shops, newspapers, media sources, museums, libraries, etc.). This approach of researching was taken since it is important for the researcher to understand the unique nature of the situation and appreciate professional judgment based on hands-on experience and interpersonal awareness, which are conceived as equally important as crude statistics/data and/or scientific evidence.

1.6 Data collection

The quantitative data used to develop theoretical models in this study are secondary data, from the following sources:

- UN's database: Human Development Index (HDI), Life expectancy and Gini coefficients data
- Global Footprint Network: Ecological Footprint country-specific data
- New Economics Foundation: Happy Planet Index (HPI), Life satisfaction data
- Global Innovation Scoreboard: Global Innovation Performance
- OECD Statistics

- Sweden Statistics
- Denmark Statistics
- Nordic Statistics

The qualitative data are mobilized from the interviews and discussions with university professionals and practitioners in the educational sector, schoolteachers, school headmasters of four schools in Lund, Sweden, managers and directors of innovation department of different companies, researchers at research institutes, and personal observations and daily interactions with different people in different locations and situations. Local newspapers in English are also consulted as supplementary source of information in case studies of Sweden and Denmark.

1.7 Assumptions

The starting point for this study is a set of assumptions that are presented below.

Firstly, technological change has an impact on the sustainability equation by creating new uses for the same materials, and newly accessible "materials" and energy fields within the earth, above the earth and off the earth also impact the equation.

Secondly, for industrial societies, there is at least some human choice that can change environments and thus repattern cultures; that the causal arrow is at least partly from humans, and possibly in two directions in an interactive relationship.

And thirdly, social preferences are not simple aggregate summations of individual choices and decisions, but also the patterns of production (what to produce and how to produce them) and the embedded decisions under the influence of companies, businesses and other institutional settings. Cultural context can be influenced and shaped by the government and the conditions in which individual choices appeared to be negotiated are those that can be changed. These conditions include technology, market design, institutional arrangements, the media and the moral framing of social works.

1.8 Structure of the thesis

The thesis comprises 7 chapters. The detail structure of the thesis is described below.

Chapter 1. Introduction

This chapter introduces the apparent incompatibility of sustainable consumption and technological progress in industrial societies and the lack of research on choice models towards sustainability, as the problem background on which the study is undertaken. The chapter also introduces purpose and objective, research questions, scope and limitations, research approach and methodologies, and assumptions of the study.

Chapter 2. Clarifying the Concepts of Sustainability, Innovations and Social Preferences

This chapter introduces definitions of terms and concepts that are to be repeatedly used in this study and that carry distinct meanings and well-defined applications. The concepts that are defined and some of them are redefined in this chapter include Sustainability, Sustainable consumption of natural resources, Technologically innovative societies, Quality of life and social satisfaction, and Social preferences and cultural determinism.

Chapter 3. Previous Models of Consumption, Technological Change and Sustainability: A Literature Review

As the name of the chapter says, this chapter presents a review of some selective theories on how social preferences are determined and influenced in certain environmental contexts, capturing the most relevant discussions of previous models regarding consumption, production, technological change and sustainability. Research works and discussions on sustainable consumption placed in the multi-dimensional context of sustainability are also presented in this chapter. These are cross-disciplinary and range from ecological perspective, psychological works, and cultural analysis to economics theories and technological innovation theories.

Chapter 4. Preliminary Exploration – Quantitative Modeling of Linkages between Consumption, Innovation and Social Preferences: Static and Dynamic Models

In this chapter, hypothetical models of sustainable societies are developed based on four factors: resource consumption, quality of life, social equality and technological innovativeness. The correlation between factors of each pair, one of the factor in any pair is resource consumption, is analyzed to detect "patterns" of choice. A multi-factor analysis follows at the end of the chapter examining "choices" in a complex matrix of influencing and interdependent factors and variables. Static and Dynamic analyses are used to identify "patterns" of choice.

Chapter 5. Testing of Theoretical Models – Case Study Comparison of Choice in Similar Environments: Sweden and Denmark

This chapter presents the results of the testing of theoretical models that have been developed in the previous chapter in Sweden and Denmark, the two societies in the similar environments. Thought experiment and path analysis of social choice are the two methods used.

Chapter 6. Discussion: A Model for Transition to the "Ideal" Innovative Society

This chapter introduces a discussion of what is a transition model toward the "ideal" innovative and sustainable society.

Chapter 7. Conclusions and Recommendations for Research and Policy: The "Good Society"

This last chapter concludes by introducing various principal findings as well as recommendations for policy and future research.

2 Clarifying the Concepts of Sustainability, Innovations and Social Preferences

This chapter starts by introducing definitions of terms and concepts that are to be repeatedly used in this study and that carry distinct meanings and well-defined applications. The concepts that are defined and some of them are redefined in this chapter include Sustainability, Sustainable consumption of natural resources, Technologically innovative societies, Quality of life and social satisfaction, and Social preferences and cultural determinism.

2.1 Sustainability

Decades of almost unchecked growth have produced increasingly striking evidence of environmental devastation and natural resource exhaustion largely caused by human activities. Yet even with tremendous "growth," the world has yet to reach a state where all people on the earth enjoy well-being that reflects the global four-fold increase in private consumption expenditures since 1960 (Worldwatch Institute, 2004). Since the early 1990s, the concepts of sustainable production and consumption have been promoted, largely as an eco-efficiency movement on the production side of the sustainability equation. In 1992 at the international conference on Sustainable Development in Rio de Janeiro, the international community came to widely acknowledge that the current production and consumption patterns of societies are "major causes of continued deterioration of the global environment", and largely unsustainable (Principle 8 of Rio Declaration, and Chapter 4 of Agenda 21 Declaration). A vision of sustainable development for the planet entails fundamental changes in the way societies produce and consume.

The ecological limit is one of the dimensions of sustainability. Wackernagel Mathis and Rees William argue that "conceptually sustainability is a simple concept: it means living in material comfort and peacefully with each other within the means of nature" (Wackernagel & Rees, 1996). For Herman Daly, "sustainable development is progressive social betterment without growing beyond ecological carrying capacity."

Ecological sustainability carries in itself the meaning of local and global contexts. Sweden is ecologically sustainable within its own "sustainable resource basket" if its rate, level of resource consumption, waste generation (or ecological footprint) and biocapacity are compared without looking at its trading patterns. Yet Denmark is overshooting its carrying capacity even if its footprint is similar to that of Sweden.

The global equity aspect (intra-generational) in sustainability definition was emphasized in the Brundtland Commission's Our Common Future (Brundtland, 1987) as half of the concept of global equity in human sustainability and human development. Global resources on earth should be used and preserved in an equitable manner, equitably distributed amongst peoples.

Trans-generation equity is another dimension of the sustainability formula. Brundtland's Commission's report (Brundtland, 1987) emphasized "[human] development that meets the needs of the present without compromising the ability of future generations to meet their own needs".

Given the "finite" lifespan of the Earth, I would argue that sustainability of humankind has one more dimension to consider, the ability of humankind to understand the universe and the relationships between the Earth and other planets as well as our chance of survival and progress as a natural species in the universe. Better understanding the human body and its environment on earth and off the earth is part of the journey toward progress.

Sustainable development = **Social justice and equity** (Human diversity and Equity, currently measured by Gini index for social equity at national level with a relative comparison among countries) + **Progress** (Human welfare and Innovation, technological, social and artistic or other forms of humanistic development) + **Ecological sustainability** (sustainable consumption and production within environmental resource limits)

2.2 Sustainable consumption of Natural Resources

The sustainability equation that balances population and per capita consumption within limits of natural resources remains strikingly out of balance for the world despite huge advances in productive growth and international recognition of the importance of sustainability. The problem does not seem to be on the productivity side of the equation (though there is good reason to believe that productive gains are now slowing and will continue to slow) yet it is rather on the side of consumption.

Following Elkins's notion of "mistaken belief" of the positive correlation between consumption of material things and happiness, Brown and Cameron (2000) defined overconsumption as "an use in excessive of goods and services which occurs from the "mistaken belief" that possessing and consuming an increasing quantity as well as wider range of goods and services leads to personal fulfillment, well-being and confirmed social status" (Brown & Cameron, 2000). There have been many studies providing vivid evidence of the "excessive use" of material products and energy-intensive services (i.e. (Durning, 1992), (Weizsacker, Lovins, & Lovins, 1997)). While it is widely acknowledged that human basic needs are actually finite and universal (Max-Neef, 1995), various ways of meeting those needs by excessive forms of "being, having, doing and interacting" (Jackson & Marks, 1999) are in the end piling up material needs that are disproportionate with respect to satisfying underlying fundamental needs and achieving happiness.

The overconsumption phenomenon has been widespread not only in "consumer societies" such as industrial countries, i.e. US, Japan, Western European countries, but also among increasing number of wealthy people in emerging economies such as India, China, South East Asian countries, and even in poor countries in the world. Though the levels of excessiveness in consuming resources vary in these countries, the fundamental question is whether each level and pattern of consumption is within the capacity of respective local environment and ecosystems to support and sustain that level of consumption for long-term progress and sustainability. Though the trade issues are recognized in this context, the integrity and carrying capacity of local ecosystems and its resources is truly the fundamental matter that in turn ensures the integrity and sustained capacity of the regional and global ecosystems and the overall global pool of resources that support human development.

Carrying capacity applicable for humankind is not about the maximum population size, but the maximum "load" that can safely and persistently be imposed on the ecosphere by people (Wackernagel & Rees, 1996), (Catton, 18 August 1986). According to Wackernagel and Rees, "population, both its size and rate of growth, and per capita consumption are built-in factors of the "human load" function that is imposed on the ecosystems". Ironically, per capita consumption is increasing even more rapidly than population due to expanding trade and technology and the load generated by human already exceeds sustainable returns from the nature (Wackernagel & Rees, 1996).

Yet, human societies have still failed to follow this rule of nature, when the human activities overload the ecosphere; the impacts need to be gradually reduced at the minimum safe line. There have been many research works devoted to identifying the dilemmas in dealing with the overconsumption of natural resources. First, it is the uncertainty about the resource pool,

though there has been evidence that this pool has been drying out and will soon be running out. The second dilemma is that different access and preferences to resource use exist among cultures and peoples. This point is important with respect to choices on sustainable development determined by different cultures. Thus it's important to understand why societies choose specific models of sustainability, with respect to their natural resource pool and cultures.

2.3 Technologically innovative society

In this paper, technological society and industrial society are used interchangeably. While this study does not equate technological innovation with economic competitiveness, the current and consensus usage of this term "Innovation" equates a society's innovative performance with its economic competitiveness in a relative scale compared to other societies.

While this study looks at the issue of sustainability from a broader perspective with respect to innovation and creativity – technological, social and other humanistic aspects of innovation and creativity, only measures of technological innovation at country level are used to develop models. This is so due largely to the availability of such a measure, quantitatively.

Technologically innovative society is a society where capacity to innovate technologies is highly ranked on international evaluation systems. Current innovation performance indices are in fact a measure of economically comparative advantages amongst economies, rather than pure measure of technological innovation or scientific and technological progress. This study however uses the Global Innovation Performance Index to relatively measure the technological innovativeness of the countries selected, with recommendations for adjustment of the measure at the end of the paper. Therefore, the societies that are labeled as "technologically innovative" societies in this study are not perfectly innovative societies in its strict definition.

With respect to innovation in sustainable development, there is now a broad consensus that "adequate and targeted innovation is a key factor to getting closer to sustainable development" (Fleischer & Grunwald, 2008). But what is "adequate" innovation? To find an answer for this question, it is necessary to look at technical parameters and social and institutional aspects to measure real impacts of new technology. Technology assessment method and Future technology analyses are some tools for "society" to measure and decide to act upon any potential impacts of a new technology, thus a "collective" choice on "adequate" innovation is possibly made. However, as many scientists warn us, "sustainability potentials" of technologies such as in the case of nano-technologies are not risk-free since "potentials for sustainability" of a proposed technology is currently just a catchword especially in the current competitive development paradigm where funding application is trying to sell out the technology's potentials to sustainable development in which only environmental dimension of sustainability of new technology is in the focus (Fleischer & Grunwald, 2008).

A widespread consensus definition of innovation gives it a very broad meaning and applications. As in the Innovation Action Plan of Denmark for the period of 2007-2010, "innovation is not solely the development of new ideas or the use of new technology in business, innovation is also achieved by disseminating existing know-ledge/ technology and using it in new ways. Innovation is also about renewal, rethinking and creating yet unseen combinations" (Danish Agency for Science Innovation and Technology, 2007).

For many scientists and researchers, technology plays a significant role to sustainability of humankind development (Weizsacker et al., 1997), (Ausubel & Langford, 1997), (Grubler, 1998), (Sikdar, Glavic, & Jain, 2004). Placed within the current understanding of the sustainable development of humankind, these scientists which raise no dim questions of a

globalized world and reduction of consumption and production both for highly industrialized and lesser developed countries, emphasize the role that technology plays as relevant in the following aspects:

- Scarcity of natural resources: mainly focused on efficiency of current technologies, or development of new technologies to replace non-renewable resources by renewable resources

- Limited carrying capacity of the earth: actually meant, development of new technologies to replace the old ones in order to reduce emissions and waste generation, and to regenerate damaged/fragmented environments

- Intra- and inter-generational equity: distribution of risks and benefits of new technologies among populations across the globe

- Participation in sustainable development: public opinion and participatory decision-making process to shape technologies for sustainability

However, to what level technology would be embedded into the societal fabrics so that the rebound effects of technological progress would not exceed the efficiency gains is never adequately discussed.

2.4 Quality of life and social satisfaction

This study is not an attempt to seek for a most consent definition of quality of life, which is obviously a paramount challenge due to the elusive nature of this multi-dimensional concept. Furthermore, there has been no "standard definition" of the concept (King et al, 1992, and Sullivan, 1992 in (Evans, 1994). However, "quality of life" is important in the development of social models of industrial society as ways of seeking to interpret the motivations and impacts of consumption and technology and for developing a model of sustainability that takes human psychological and physical "needs' into consideration.

For the purpose of the current research, quality of life is defined as subjective well-being, which is mostly equally considered as health. Therefore, by this understanding, increasing quality of life equates to increasing number of happy life years. Also by this understanding, quality of life is used interchangeably with life satisfaction and happiness, to name some among many more other concepts. Though they are of highly value-laden concepts, they are slightly distinctive in this research: life satisfaction is measured as more subjective reflecting the emotional state of individuals, while quality of life is more systematically measured reflecting both the physical and emotional state of individuals in a more balanced nature, which frequently equates to life expectancy, life satisfaction and social equity.

2.5 Social preferences and cultural determinism

There is a distinction between "preferences" versus "cultural determinism" in which the latter concept actually means cultural choices imposed by environmental constraints. People in the same value-oriented society may act differently due to various preferences. Such as decisions relating to purchases; fair trade or eco-labelled or second-hand products, or another decision of which to support, locally produced or imported organic products, etc. are decisions based on preference of choice (Stern, Dietz, & Guagnano, 1995).

The hidden assumption of social policy choice is that human beings and cultures can make independent choices that are not determined by environment and other biological factors and constraints. Some social scientists believe that all choices are really driven/determined by these

other variables and that causality is "reversed." The assumption of this paper, for industrial societies, is that there is at least some human choice that can change environments and thus repattern cultures; that the causal arrow is at least partly from humans, and possibly in two directions in an interactive relationship.

Preferences and wants differ for different societies and change with time when societies evolve. Social preference is used in at least two different ways: decision mechanisms that reveal the preferences of society; and the actual judgment of what is better or worse for society. For example, energy intensity is not only a technological factor but also a structural and cultural factor that is determined by socio-economic choices or possibilities. Structural change in energy intensity would happen when there exists a shift from an economic activity of higher energy intensity to another of lower energy intensity, for instance (Mulder & Biesiot, 1998).

2.6 Social preferences for current societies on earth and future "planned" societies on earth and beyond

There is a philosophical question about whether social preferences for consumption, ecological well-being, social equality and technological innovation are really just "choices that are NOT YET constrained and determined by resource limits" but that ultimately are determined once humans come closer to the limits. For example, economists believe that consumption is unlimited and that there are always new resources to use, but that philosophy is only put to an empirical test when resources run out (and humans are extinct) and may be unknowable. Similarly, social equality may or may not be an essential fundamental feature of a sustainable society in a resource base, but we may not know that until we continue to experiment with civilizations that rise and fall due to civil wars and conflicts, and ultimately learn to test whether an equitable society that is technologically advanced outlives the inequitable societies that have been the story of most of human history. (The longest surviving ones to date are only about a century old; shorter than the longest individual human lifespan.)

There are also questions as to whether human beings have the biological ability to make such choices that can be theoretically imagined, such as actual equality (not found in the primate world other than a near equality in Bonobo chimpanzees and possibly not genetically programmed into human primates), restrained consumption, or technological growth societies that also fulfill human, non-material desires for intellectual and spiritual expression and development. There is a question as to whether human societies that choose peace are viable while competing with human societies that choose war; while the history of most human cultural extinction and survival offers a pessimistic answer to this question.

3 Previous Models of Consumption, Technological Change and Sustainability: A literature review

This section starts with the review of some selective theories on how social preferences are determined and influenced in certain environmental contexts, capturing the most relevant discussions of previous models regarding consumption, production, technological change and sustainability. Research works and discussions on sustainable consumption placed in the multi-dimensional context of sustainability are also presented in this chapter.

In a search of the environmental policy literature, the environmental economics literature, and some work in related social sciences, the author found no existing scientific theory in this area to be proven or disproven by the research and no specific models. What the literature contains are several untested assumptions that then form the basis of other work. The Kuznets hypothesis/theory which was introduced in the 1950s to prove that there existed an inverse U-shaped correlation between environmental quality, i.e. pollution (air, water) and changes in income per-capita also appears irrelevant to be applied in this study given the Kuznets hypothesis's narrow aspect of "environmental quality", which is the *output* of human activities, versus the issue of consumption of overall natural resources in much broader scope in this study and also that is the *input* of human actions and interventions. However, to a certain extent, this study and its results would possibly be seen as another effort to disapprove Kuznets hypothesis within the scope of the study.

This study does not apply a single theory or a single framework given its broad approach to find answers for complex issues relating to social preferences and choices in respect to innovation and consumption within the realm of sustainability. The researcher however attempts to present a survey of different "philosophies" that underlie various disciplines touching on the questions of productivity, innovation, sustainability, and the "good society." Most of these are cross-disciplinary and are difficult to classify in any one "line" of scientific development or hierarchical construction of knowledge and provable social scientific "equations." These range from ecological perspective, psychological works, and cultural analysis to economics theories and technological innovation theories. These are presented below in the order of consumption related, economics, and technological development theories.

3.1 Consumption Related Theories

3.1.1 Ecological theory

The main argument of the Ecological theory is that environmental limits are the ultimate constraints shaping the culture and collective choices of societies. Cultural contexts, the environment in which individuals interact with each other and with the environment itself, equates to the ecological determinants of the choices made by a given society. From the ecological approach, Wilkinson (1973) provided a description of how primitive societies managed and controlled over their resources and population as well as private desires of possessing and accumulating wealth in relation to the finite pool of local resources. Relationship between the rates of environmental exploitation and the level of economic development or level of technological innovation and advancement was also examined under the social anthropology perspective. Ecological constraints bring about stimuli needed for change and for adaptation. However, the study does not try to sufficiently explain the underlying reasons why different societies choose different methods to exploit resources to satisfy their "evolving" needs given the similar ecological constraints (Wilkinson, 1973).

The ecological theory presented by Wilkinson (1973) observed and described the practicalities of technical change, economical optimum set of decision/ choice among alternative options available and feasible ("economic efficiency" defined as culture of "trade-offs relationships, which are created between the cost of fiction, working through network of technical interrelations"), cultural roles in determining which alternative options should be chosen or denied in primitive or "pre-contact" societies. In other words, the ecological theory provides a way to answer the question of how different societies have adopted different methods of exploiting the environment as well as determined the levels of this exploitation in order to cope with limits imposed by the environment. From the history of human civilization, the evolutionary theory does not attempt to explain life in harmony and maintenance of progress. However, the fundamental difference between studied "pre-contact" societies and modern societies is the complexity of social and institutional structures of modern societies as well as the interactions among different social actors in decision-making, be it a less or fair democratic process. Therefore, another angle to look at this question should expand to also study the roles and interactions between various factors in political environments or power structures of societies when it comes to decision-making processes especially in industrial societies. It is so because "social institutions can actually prevent or allow adequate responses" (Wilkinson, 1973).

According to the ecological approach, in respect to the relationships among various trade-offs, the direction of development appears to be dependent on the ecological context, which is presented in the internal as well as external price structures. But how the price structure is created and whether or not it fully reflects costs associated for the whole of society (and its natural environment) are among the missing questions.

According to the ecological approach, there exist "successive ecological problem shifts" when new technologies are developed and chosen to replace old ones; it that case the ecological problem or situation becomes shifted to another degree or nature. "The changes are merely offsetting the mounting ecological difficulties" (Wilkinson, 1973). But it is not the case where natural resources are abundant elsewhere and accessible to those people in the exhausted resource areas. They just migrate to the new areas, and the problems need not to "become sufficiently acute to stimulate invention" (Wilkinson, 1973). An example of this phenomenon is the "Westward" expansion in the US – people just migrated to new areas where fresh land and virgin resources were not "mined" out yet (Wilkinson, 1973). Is it the same ideology of considering earth as a temporary stop for human kind before landing on other planets? Is this an ideology that has a deep root in the culture of any societies or cultural groups, which influence largely their actions toward how their nature is used and conserved?

In the modern time, collective decisions may be made in the consideration of the precautionary and/or reflective principles.

3.1.2 Evolutionary psychology theory

It distinguishes between needs (which are finite) and satisfiers (the ways chosen to satisfy those needs, which may vary over time and across cultures). This theory explains the human nature in terms of consumption behaviours by highlighting the "multiplicity of behaviours" and "complexity of proximal motivations" that induce human actions. This evolutionary theory shares with the needs-based theory the assumption that certain aspects of human nature are universal. However, the evolutionary theory differs from the needs-based theory in its assumption that "seduction" (a concept coming out of Freudian psychology) is the universal driver for genetic succession. The evolutionary theory also tries to explain the mismatch between economic growth and human well-being by using the "evolutionary adaptation" approach, although it is still difficult to grasp the main arguments of this theory to explain why human adaptation to its evolving environment has led to increasing consumption,

as well as why one of the evolutionary psychologists suggested that "sustainability does not come naturally" to human species (Jackson, 2003). Darwin, himself, opposed any attempts by social scientists (such as the "social Darwinists" (Summer, 1963) in the 19th century who argued that the "GDP driven" societies were at the "top of the evolutionary ladder" and were "morally superior") to suggest that human societies or any society followed a linear path where success could be measured in any quantitative way. Darwin's theory of evolution was one of diversity and adaptation ("adaptive radiation") in which any level of survival had equal value and any level of consumption was "successful" as long as the group, of whatever size, found a niche in which it could survive.

3.1.3 Global governance framework

Global Governance Framework (Fuchs & Lorek, 2005) also called **Dependency Theory** and **Corporate Globalism** (Korten, 1995) by previous (perhaps, more courageous) scholars: It argues that in the past decades, global politics are no longer characterized as interactions between states as primary actors, but international organisations have emerged to have increasingly important roles in shaping and significantly influencing how global politics work. However, to explain the failure of those international organisations in advocating for the "consuming less measures", it suggests that it is because of the weaknesses of those international organisations. The framework also suggests an approach to examine the potential strengths and weaknesses of international organisations in global governance issues including economic, social and environmental ones. It argues that the "strong sustainable consumption issues" have been avoided on the international agenda largely due to the weaknesses of international organisations and the alliance of consumers and businesses to oppose to strong sustainable consumption suggestions. However, using this framework one cannot explain the vested interest of those international organisations and how much influence they can have over the global issues given the roles some of the international organisations have been assigned by governments such as United Nations and its systems, or why they are not that "strong" in influencing the international politics in the sustainable consumption issues.

In a Fuchs and Lorek's work, the global governance framework was used in an attempt to explain the increasing role of international organisations in shaping international policies dealing with global governance issues. Fuchs and Lorek reaffirmed the self-positioning of governments in the debates and their own national policy development in this regard that is fundamentally influenced by "the voters and powerful parties" in pursuing an increased welfare and economic growth. Of course, other relevant question would be whether economic growth ensures an increase in social welfare and happiness, which is not within the framework of the present paper. However, another question could be who are the voters and powerful parties? Are they acting and regarded as citizens with full freedom of exercising their rights or solely those who are turned into consumers by business-oriented interest vested groups? Whose voice is that that they are representing given the fact that multi-media corporations and multi-national corporations have tremendous influence on shaping the way information is "produced" and transmitted? How to explain why this society decides to do this while other societies choose to prioritize the other way?

However, fundamental questions have not yet been raised in seeking an understanding of the underlying constraints to a "strong sustainable consumption approach", among which are given as follows: what could be underlying reasons for why the current "global and political settings" actually hinder a recognition of a substantial reduction in consumption levels and considerable change in consumption patterns?

3.1.4 Cultural theory

This theory was originated in Mary Douglas's work on "anthropology of consumption and public attitudes to risk", in which individual and household consumption behaviour is examined under the light of its intertwined links with "social values and meanings, cultural allegiance and social relationships". Therefore, preferences are made "not within individuals" but as a result between people in the society. Therefore, under this theory, consumption is considered as a "moral activity" that is made only to strengthen "social solidarity" carrying "symbolic meaning of collective values and interrelationships". A matrix of four competing worldviews associated with social solidarity and social organisations is presented in Doublas's work. According to the proponents of the Cultural theory, this matrix is universally applicable as well as equally applicable in scale, i.e. both household and country levels. Seyfang (2004) has applied this framework in critically analysing the UK's strategy for sustainable consumption and production, which showed that this strategy was "strongly biased towards individualistic, market-based and neo-liberal policies" (Seyfang, 2004).

3.2 Production, Consumption and Development: Economic Theories

The measure of gain in the world system has been that of either productivity per capita (GDP) or consumption per capita. The current development thinking is overwhelmingly driven by neo-classical economics theories, which actually represent market ideology. This is the ideology of private consumption and that government has a role in promoting it. As Eli Ginzberg explained in his essay, "government is a fourth factor of production" (cited in (David & Reder, 1974)).

Though consumption is positioned only in microeconomics, meaning consumption at individual or household level, under neo-classical economics, consumption is related to income, thus employment and investment at the macro level. In this field, Keynes's consumption theory is considered the most influential that set an initial cornerstone for the contemporary consumption theories. In his *General Theory of Employment, Interest and Money* (1936) Keynes examined the relationships between income and levels of consumption, in which he showed the level of personal consumption was positively influenced by individual income. The theory also deals with savings and taxes that an individual has to deduct from his/ her income that in turn influences the level of consumption of that concerned person. An entire economy was then analyzed as comprising such individuals, thus Keynes's theory was considered as being able to "predict how an economy would react to changes in its national income with respect to its aggregate consumption" (Miller, 1996). Keynes's followers have also supplemented Keynes's theory with more arguments, such as Milton Friedman who looked at changes in individual consumption over a longer period of time (i.e. long-term income, for example expected income in a decade or so) (Friedman, 1957), or Franco Modigliani and Albert Ando who studied the responses of consumption towards permanent incomes of the entire lifespan of a concerned individual (Miller, 1996). In general, the consumption theory was developed based on the fundamental assumptions in the neo-classical economics: consumer sovereignty principle and unlimited resources principle.

a. Consumer sovereignty principle

Neo-classical economics was developed based on the fundamental theories of utility maximization for individuals and profit maximization for companies. Under its utility theory consumers are assumed to be rational in their decisions of buying, which are determined by their rational preferences (Norton B R Costanza & Bishop R C, 1998). Since the neo-classical economics assumptions of the rationality of consumers and the consumer sovereignty are still prevalent, the question of whether to limit consumption poses another dilemma of whether or not such an action from the state is to infringe the right to consume of its citizens. As an

example, after the Depression and World War II periods, the democratization of consumption was boosted in the US society, in which citizens were turned into consumers under the open market economy, a way to boost up the country's economy.

b. Unlimited resources principle

For economists, there is no such thing as scarcity and limits to resources and overconsumption is a "myth". New resources simply need to be "developed" by market incentives. According to the market ideology of production, it is overconsumption that creates the "need" and "drive" for development of new technologies that will restore the balance between production and consumption. Similarly, (relative) "scarcity" of resources simply creates market incentives to find "alternative substitutes." Even after the Club of Rome report, *The Limits to Growth* by Meadows *et al.* was released in 1972, "[by] the mid-1980s, resource scarcity had virtually disappeared as a public theme" (Weizsacker et al., 1997). The attention has been on development and poverty eradication.

Development means the priority to eradicate poverty needs more goods and services to be produced and an increase in consumption means a "healthy" economy in which more jobs are created and some people would be better off even if the gap between the rich and the poor has widened. This reflects the compensation principle developed by (Hicks, 1939) and (Kaldor, 1939). According to the compensation principle, economic efficiency is defined when the amount of all the benefits is great enough to equalize all the costs, whether or not those who bear the costs are compensated from the benefits. The Hicks-Kaldor criterion is the basis for the cost-benefit analysis.

"Development of need is the real cause of economic development" (Wilkinson, 1973). Neo-classical economics equates all kinds of human needs, including social, psychological needs, with material needs, meaning that material goods will satisfy all. Thus, most governments have a prevailing perception that reducing consumption levels would undermine economic goals, technological innovations and commercial competitiveness on global market (Mont & Plepys, 2007).

However, there are various limitations of neo-classical economic theories regarding environmental externalities.

Most of growth models (interested in changes in per capita income) and development theories (Keynesian theory, for instance which is interested in short-term analysis) fail to distinguish between quantitative expansion and qualitative change (Wilkinson, 1973), between short-term gain and long-term development. Technological advances are believed to help solve all problems that emerge from open-market economies. However, the problem of finding solutions, which are suitable and capable within the productive potential of a society's established technology, is amongst the most challenging obstacles to development in general (Wilkinson, 1973).

One of the major limitations of neo-classical economics lies in its micro-level approach, meaning that it largely ignores the problem of scale of the economy both in space and in time due to its fundamental assumptions of infinite resources and substitution possibilities as well as boundless technological change and innovations. According to neo-classical economics, relative scarcity of resources simply enhances a change in technology to look out for substitutes, which are out there available and abundant in variety and amount. Therefore, it never poses the question of the limit of a sustained economy. For neo-classical economists, economy is considered as a separate system staying outside the ecosystem independently, which has no boundary to limit its expansion to every dimension (Daly, 1996). For this reason,

neo-classical economics ignores social and environmental costs associated with economical activities.

The "utopia" assumptions of neo-classical economics about the perfect market in which information is fully and relevantly communicated to consumers who are assumed to behave rationally, i.e. utility maximizing, while companies are assumed to be always trying to maximizing benefit, make it fail to sufficiently explain individual's consumption processes. The conventional economic views suppose that reason alone is sufficient enough to distinguish between different actions regardless of other underlying motivations. However, consumer behaviour has been found to be much more complicated, involving not only rational response to price signals within their income, but also influenced by human psychology, social norms, cultural and social institutions, and institutional settings (Daly & Cobb, 1989), (Daly, 1996) and (Mont, 2007).

Max Neef (1995) presented his **threshold hypothesis** about the relationship between economic growth and human welfare, in which he examined and tested the hypothesis that human welfare and economic growth are increasing positively hand in hand for a certain period of time when the situation reaches a threshold, when economic growth leads to increasing human welfare, but after that point, economic growth does not help increase social welfare. Even by this hypothesis, GDP – a traditional indicator of welfare, appears to be inappropriate in measuring welfare and happiness (Mont, 2007).

The pursuit of environmentally-sound technologies cannot be used as an excuse to avoid questions of over-consumption and increasing material inequity (Wackernagel & Rees, 1996). Sweden is among the few high-income countries that can support themselves within the local carrying capacity (together with Canada, Australia, New Zealand), but only due to their relatively small populations and extensive land surfaces. However, Sweden is still more and more living on an ecological carrying capacity "imported" from outside. But the follow-up question is not for how long it will be before we run out of "somewhere else" (though the answer is we already have), but "which quality of sustainability Sweden is striving for". According to Wackernagel and Rees (1996), "the greatest contribution the developed world can make to sustainability is to reduce its resource consumption by all means at its disposal. The "factor-10" efficiency revolution may be the politically most acceptable approach, but there may well be greater ecological, community and personal merit in learning to live more simply so others can live at all."

According to the physic laws on thermodynamics, environmental limits and natural assets are fixed, thus unable to be expanded or created respectively by trade and technology. Generating more efficient utilization of resources does not automatically lead to resource savings and reduced consumption. "Because even in the best circumstances, technological innovation does not increase carrying capacity per se but only the efficiency of resource use. In theory, shifting to more energy- and material-efficient technologies should enable a defined environment to support a given population at a higher material standard, or a higher population at the same material standard. However, while this seems to increase carrying capacity it actually only holds total human load constant in the vicinity of carrying capacity. The latter is unchanged and ultimately still limiting." But even in practice, the situation is worse. Any efficiency gains and current incentives often work, directly or indirectly, against efforts of resource conservation. Many factors contribute to this phenomenon, including price, income effects of technological savings (rebound effects) (Wackernagel & Rees, 1996).

If each nation were to export only true surpluses – output in excess of local consumption whose export would not deplete self-producing natural capital stability. However, access to cheap imports lowers the incentive for importers to conserve their own local natural capital

stocks (e.g. agricultural land or forests) and may result in the competitive depletion of the exporters' assets as well (Wackernagel & Rees, 1996).

According to economist Paul Samuelson, technical innovations or efficiency gains account for 75% of Gross National Product (GNP) growth, thereby contributing to increased aggregate resource throughput (Samuelson & Nordhaus, 1985). Analysing the effects of efficiency gains, economist Harry Sanders concludes that "… energy efficiency gains can increase energy consumption by two means: by making energy appear effectively cheaper than other inputs; and by increasing economic growth, which pulls up energy use …" (Sanders, 1992) GNP and energy consumption has never been decoupled in industrialized countries. Thus, the link between economic activity (measured in GNP) and energy use is stronger than believed by most neo-classical economists (Wackernagel & Rees, 1996).

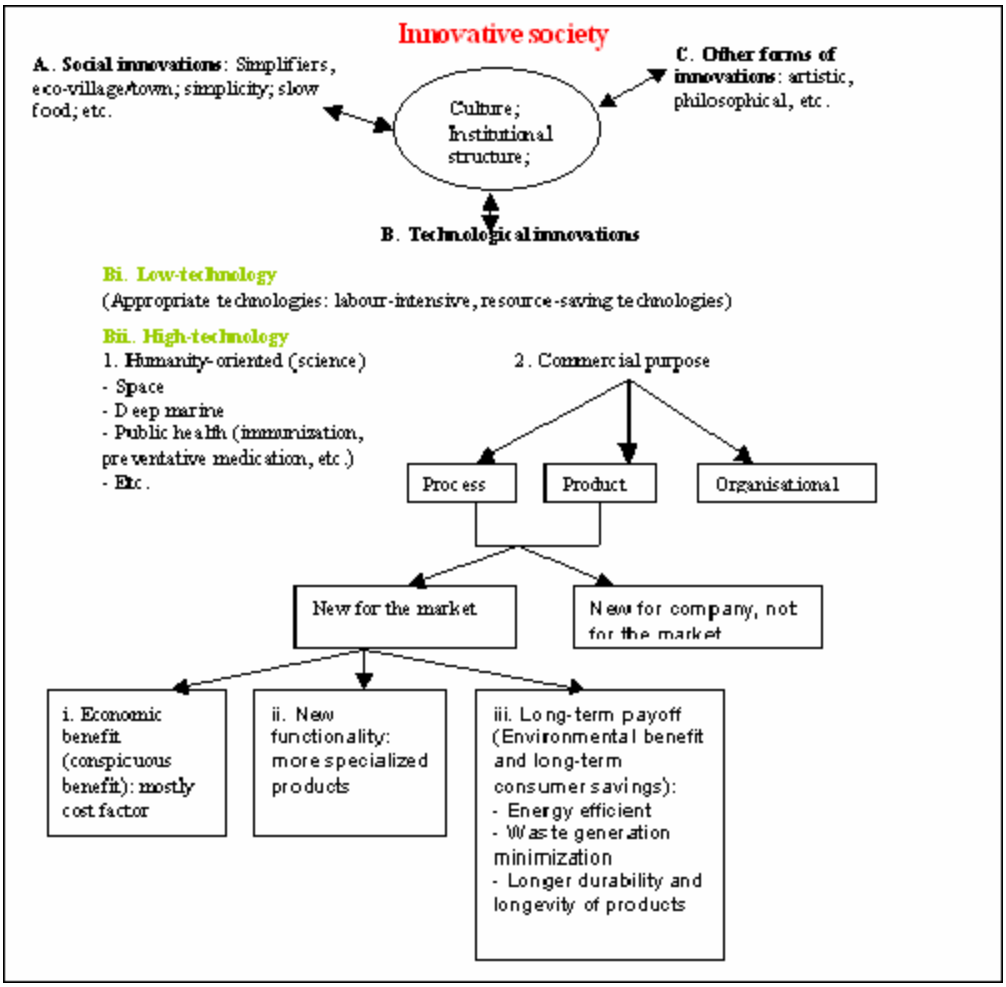
3.3 Technological innovation versus other aspects of human innovation and expression

Different cultural perspectives on what is called "innovation" or being innovative in a certain society: For example, industrial countries conceptualize innovative ideas as those relating to products or services, which is made for markets or implemented in production; however this is not the case in many other countries. For many countries in Asia for example, being innovative may mean being creative philosophically or spiritually.

By looking at technological innovation, this study looks at the possibility of business-type innovations to assess how far technological innovations can progress in sustainable resource consumption. This is mainstream business innovation, not "grassroots innovation" (or social innovation) which is initiated by communities within local contexts to respond to local situation. Literature in the field of innovation, both mainstream business and socially grassroots origin, shows a lack of research on innovations in other forms of human development and expression. Created capital and natural capital are just complementary goods; as we consume more created capital, we will also have to consume more natural capital (Elliott, 2005).

The figure below illustrates the concept of an innovative society where full human development is attained.

Figure 3-1 Conceptual Innovative Society, conceptualized by author



Note: "Product" in Bii.2 comprises both product- and service-oriented innovations.

3.4 Social equality, Quality of life and Material well-being

One of the incentives for grassroots innovation initiatives in communities is to increase the quality of life in the local communities, not as environmental organisations (Seyfang & Smith, 2007). Many grassroots innovations come from socially and/ or economically excluded communities who might actually "dream of mainstream consumption". Thus many of those initiatives seek to build capacities for the initiating communities to participate in the mainstream (Seyfang & Smith, 2007). There are two main motives that drive communities to seek for local tailored innovations: social needs (or niche) and ideology.

In Tapp and Watkins's work (1990) cited by (Mulder & Biesiot, 1998), Illich's threshold theory was introduced to postulate that quality of life (freedom of choices) and material standard of living are not linearly correlated. Illich's threshold theory states that there is an optimum level of material wealth for total well-being.

3.5 Social Change Models

3.5.1 Path dependence theory

Many researchers have studied technological, institutional and ecological path dependence (Hukkinen, 2004): Path dependence is defined as "the tendency of past decisions or developments to constrain our choices in the future." In technological studies, technological

momentum (Hughes T.P., 1987) and technological life cycle (Grubler, 1998) that are two factors that "lock" the development of technologies in certain "paths". In institutional theory and economic history, path dependence is described as a lock-in between institution rules and the organisations that have evolved as a consequence of the incentive structure provided by the institutions (North 1981, 1992).

According to the Consumption Surplus Index (CSI), which generally follows the Index of Sustainable Economic Welfare (ISEW, introduced by Cobb and Cobb 1994), "Survivability level of consumption" comprises all goods and services needed for biological and social survival. "Social survival means the survival of functions, structures and processes of anthropogenic systems. […] The commodities needed for social survival comprise organisational (e.g. administration), material (e.g. food, energy) and social (human and intellectual) resources. […] The survival of industrialized societies with complex administrative structures, a large number of energy consuming artifacts and a higher minimum level of education requires more material, organisational and human resources than the survival of agricultural societies."

3.5.2 Theories of change and adoption of innovations

According to **Rogers' Innovation-diffusion theory** (Rogers, 2005), there are five stages in innovation-decision-making process: (1) *knowledge*; (2) *persuasion*; (3) *decision*; (4) *implementation*; and (5) *confirmation*. Rogers also notes five qualities or characteristics of an innovation which determine its rate of diffusion or adoption and is most likely to succeed: (1) its *relative advantage* over the current state of affairs; (2) *compatibility* of the innovation to match to the current state; (3) its *complexity*; (4) *trailability* and (5) *observability* (Kratochwill, 2005). According to Rogers (1995), innovations that preserve work practices and organisational structures are most likely to succeed. This is partly the path dependence of technological development and change, where the Usherian incremental innovation type dominates the Schumpeterian radical innovation type.

As (Hellstrom, 2007) articulates, while radical architectural innovation may be the only way for long-term sustainability, in short-term it is likely to cause environmental destruction. He also adds that "incremental improvements, which are found the most common in eco-innovation, locks social practices into existing trajectories, which then become increasingly costly to break out." (David P., 1985).

For Usherian incremental improvements and refinements to happen, there are three preconditions; education, financial support and public consent.

While in the Schumpeterian type of innovation, there are four additional conditions: Strong science-base with knowledge institutions, and support for long-term payoff engineering projects; Cultural dimension (curiosity, testing by experiment and hypothesis formulation, skepticism; originality and novelty; tolerant to diversity; a culture that encourages individualism rather than consensus; risk-taking encouraging culture); market available for innovative but risky business ideas; a regulatory environment that accommodates special requirements for small and innovative enterprises.

Ayres (1996) acknowledges that reduction of material intensity of our economy while retaining human well-being depends on our ability to be innovative. Except for positional goods, it theoretically is possible to decouple economic activity from energy and materials by providing services rather than material goods if ultimate goal of economic activity is to provide the quality and better values of services to consumers, not material goods per se.

There are also a number of other theories on individual and collective choice, such as the Social choice theory and the Rational choice theory. For the scope of this study, those theories are not presented here due to their discussions on a consensus definition of rationality and how social choices are made or are considered rational or not. The rationality of a social choice is not however a focus of this study.

4 Preliminary Exploration - Quantitative Modeling of Linkages between Consumption, Innovation and Social Preferences: Static and Dynamic Models

In this chapter, hypothetical models of sustainable societies are developed based on four factors: resource consumption, quality of life, social equality and technological innovativeness. The correlation between factors of each pair, one of the factor in any pair is resource consumption, is analyzed to detect "patterns" of choice. A multi-factor analysis follows at the end of the chapter examining "choices" in a complex matrix of influencial and interdependent factors and variables.

In order to identify and analyse the possible choices of human societies on the factors above, this chapter starts by examining the range of societies that exist and their current choices: STATIC analysis of the patterns.

The examination of the data is also used to suggest whether or not there are "paths" of development in which country preferences can move along a path; if so, how many different paths there may be – DYNAMIC ANALYSIS, suggesting a time dimension. There is however a note that data has not been collected or processed yet for historical analysis and it is only possible to make suggestive interpretations of trajectories of social choices over time, as well as to seek to uncover additional factors that may be at work: peace/ insulation from war; nearing of resource limit constraints that impose a natural control.

4.1 Selection of Countries and Factors to Test

4.1.1 Selection of countries to be included in the models

As the researcher looks at various factors when developing the models of "behaviours" and "paths" of human society, the following criteria are considered when countries are selected for the tests of the research.

- Geo-political distribution: Countries representing Africa, North America, Latin America, Western Europe, Eastern Europe and European countries in transition, Asia-Pacific countries, South Asia, and Middle East and South Europe.
- The availability and accessibility to all types of data for the various factors are considered as the most decisive criterion. Given the fact that country-level data are needed for the test,
- Country whose innovation performance is rated by the Global Innovation Scoreboard is selected.

As a result, the following twenty-five countries are selected for the modeling: South Africa (Africa); Canada and the US (North America); Argentina, Mexico and Brazil (Latin America); France, Germany, the UK, Norway, Denmark, Sweden and Finland (Western Europe); Hungary and Slovenia (Eastern Europe); Russia; Japan, Republic of Korea, New Zealand and Australia (Asia-Pacific); India and China (South Asia); and Greece, Israel and Turkey for the Middle East and South Europe.

4.1.2 Selection of factors and variables

4.1.2.1 Resource Consumption: Ecological Footprint

Ecological Footprint is used in this research because it measures consumption levels of natural resources. But different to other environmental sustainability indices, Ecological Footprint

does not gauge sustainability of resource utilization (and management). Therefore, a high Ecological Footprint implies a level of resource consumption that is not sustainable over a long time, but a low Ecological Footprint does not suggest that that low level of resource consumption equates to sustainable resource use. It however suggests a relative comparison of a country's level of consumption or the "size" of its footprint against the global Earth share and the global viable footprint – current global biocapacity.

There are two ways to look at Ecological Footprint at the country-level data with respect to interpretation of the long-term sustainability of resource use by a country and its global position in resource consumption in relation to those by other countries when a global fair share (of resources) is considered. First, compare the country's Ecological Footprint against its biocapacity or carrying capacity that is a measurement of the available resource pool to support the country's current population at its current level of consumption. This comparison provides an estimate of whether and how far the country's current consumption level overshoots its resource pool at current capacity. Second, compare the country's Ecological Footprint against the global ecological footprint and the global "sustainable" adjusted ecological footprint to see how well the country's performance is with respect to global equity of resource utilization.

There are a number of other indicators to measure the ecological sustainability from the resource management perspective, such as the Environmental Sustainability Index developed by Yale University. This type of indicators measures the prospects of the sustainability of the environment in dynamics, based on management indicators. However, the purpose of this study is to look at the levels of resource consumption of countries at the time of study in static analysis. For this reason, Ecological Footprint is selected for use in this study.

4.1.2.2 Quality of Life aspects: Life Satisfaction, Life Expectancy and Social Equity

Quality of life is a multi-dimensional concept, which embraces subjective and objective indicators and measurements. For the purpose of the study, subjective life satisfaction, and other two objective life expectancy and social equity are selected as the best indicators available reflecting the combined quality of life of individuals. Life satisfaction is individually measured, then coded into a single index to reflect an overall national life satisfaction which is cultural-laden measurement.

Data on self-reported life satisfaction used in this research were deprived from the World Value Survey results, cited in the New Economics Foundation (NEF) and Friends of the Earth's Happy Planet Index report in 2006. Individuals were asked a sole question of "how satisfied they were with their lives as a whole, on a scale of 1 to 10." NEF codified and standardized the answers and presented them in an index of life satisfaction at country level, using the same scale.

Life expectancy is measured as one of the human development indicators. Life expectancy is not a crude measurement of how long a population would live, but it carries lots more information about a country's health and care systems, and the psychological well-being of its people.

For the factor of social equity, the Gini coefficients Index developed by the United Nations Development Programme (UNDP) reflects the gap in income and wealth distributions in countries.

4.1.2.3 Innovativeness: Global Innovation Index

The leading international ranking systems for "Innovation", which is equated to economic competitiveness, include the Global Competitiveness Report of the World Economic Forum,

the World Competitiveness Yearbook of the Institute for Management Development, the European Innovation Index of the European Innovation Scoreboard, and the Global Innovation Performance Index of the Global Innovation Scoreboard. Most of economists also acknowledge that these rankings are frequently superficial, unable to truly assess a country's competitiveness. However, to a certain extent, the current indices of innovative performance do reflect relative competencies of different economies regarding technological and science base and capacity.

Global Innovation Performance Index, developed by the Global Innovation Scoreboard, is a harmonized measurement of twelve indicators, grouped into five interconnected categories, of which the aggregate summary reflecting different aspects of a country's long-term economic competitiveness.

The indicators of the Global Innovation Scoreboard include: (I) Innovation drivers, which comprises (1) new science and engineering graduates, (2) labour force with completed tertiary education, and (3) researchers per million population; (II) Knowledge creation, which comprises (4) public R&D expenditures, (5) business R&D expenditures and (6) scientific articles per million population; (III) Diffusion of (7) ICT expenditures, (IV) Applications, including (8) Exports of high-tech products and (9) share of medium-high/high-tech activities in manufacturing value added; and (V) Intellectual property, which comprises (10) number of EPO patents per million population, (11) number of USPTO patents per million population, and (12) triad patents per million population.

Actually, the World Economic Forum's Growth Competitiveness Index is nothing different. In its annual World Investment Report, UNCTAD also has an Innovation Capacity Index (UNCTAD, World Investment Report 2005), in which the ranking of innovative countries is not identical with that in the Global Innovation Index.

4.2 Possible societal types: Static Models (Classifications)

4.2.1 Hypothetical archetypes of societies with different patterns of consumption, innovation, and social satisfaction

With 5 variables (consumption, innovation, life expectancy, life satisfaction and social equity), there are 32 possibilities or cases of societies. There are 16 cases where high innovation is the main character, which are relevant for this study. Amongst these 16 cases, only those with high consumption levels are of the focus of the study (the first eight cases).

Table 4-1 Hypothetical archetypes of development: High Innovation (16 cases), constructed by author

Type of society	Description of patterns			
Innovative and equitable but consumptive	Equity High Innovation Satisfied High Life Expectancy High Consumption	Equity High Innovation Satisfied Low Life Expectancy High Consumption	Equity High Innovation Dissatisfied High Life Expectancy High Consumption	Equity High Innovation Dissatisfied Low Life Expectancy High Consumption
Innovative but consumptive and	Inequity High Innovation	Inequity High Innovation	Inequity High Innovation	Inequity High Innovation

Type of society	Description of patterns			
inequitable	Satisfied High Life Expectancy High Consumption	Satisfied Low Life Expectancy High Consumption	Dissatisfied Low Life Expectancy High Consumption	Dissatisfied High Life Expectancy High Consumption
Innovative, equitable and moderate in resource use	Visionary Ideal: Equity High Innovation Satisfied High Life Expectancy Low Consumption	Equity High Innovation Dissatisfied Low Life Expectancy Low Consumption	Equity High Innovation Dissatisfied High Life Expectancy Low Consumption	Equity High Innovation Satisfied Low Life Expectancy Low Consumption
*Innovative and moderate in resource use but ineq*uitable	Inequity High Innovation Dissatisfied Low Life Expectancy Low Consumption	Inequity High Innovation Dissatisfied High Life Expectancy Low Consumption	Inequity High Innovation Satisfied High Life Expectancy Low Consumption	Inequity High Innovation Satisfied Low Life Expectancy Low Consumption

Note: High/Low consumption is measured against global fair earth share; Equity/Inequity is a relative measurement of low disparity vs. high disparity in a society

The Visionary Ideal is a conceptual archetype of development in which full human development is attained within ecological constraints.

There are 16 other cases that have low innovation performance, which are relevant for sustainability and human diversity but outside the subject of the study.

Table 4-2 Hypothetical archetypes of development: Low Innovation (16 cases), constructed by author

Type of society	Description of patterns			
Equitable and moderate in resource use but weak in innovation	Equity Low Innovation Dissatisfied Low Life Expectancy Low Consumption	Equity Low Innovation Satisfied High Life Expectancy Low Consumption	Equity Low Innovation Dissatisfied High Life Expectancy Low Consumption	Equity Low Innovation Satisfied Low Life Expectancy Low Consumption
Moderate in resource use but inequitable and weak in innovation	Inequity Low Innovation Dissatisfied High Life Expectancy	Inequity Low Innovation Dissatisfied Low Life Expectancy	Inequity Low Innovation Satisfied High Life Expectancy	Inequity Low Innovation Satisfied Low Life Expectancy

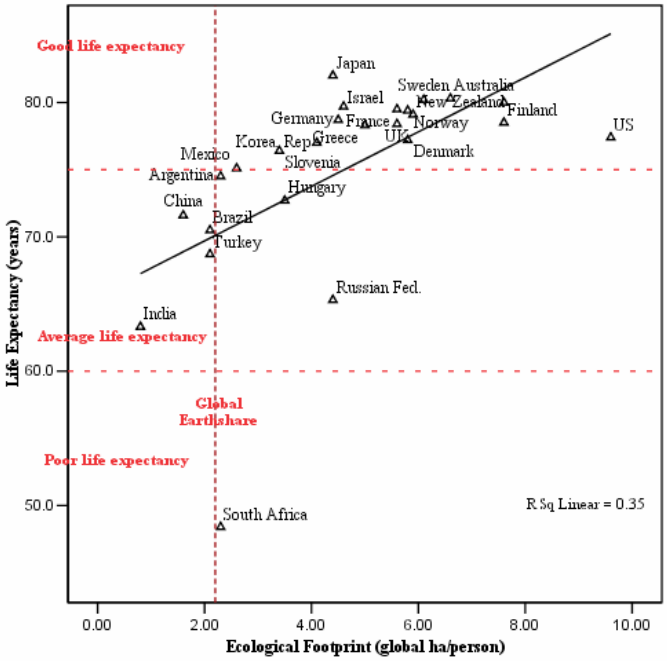
Type of society	Description of patterns			
	Low Consumption	Low Consumption	Low Consumption	Low Consumption
Equitable but consumptive and weak in innovation	Equity Low Innovation Satisfied Low Life Expectancy High Consumption	Equity Low Innovation Satisfied High Life Expectancy High Consumption	Equity Low Innovation Dissatisfied High Life Expectancy High Consumption	Equity Low Innovation Dissatisfied Low Life Expectancy High Consumption
Inequitable, consumptive and weak in innovation	Inequity Low Innovation Dissatisfied High Life Expectancy High Consumption	Inequity Low Innovation Satisfied High Life Expectancy High Consumption	Inequity Low Innovation Satisfied Low Life Expectancy High Consumption	Worst case: Inequity Low Innovation Dissatisfied Low Life Expectancy High Consumption

4.2.2 Empirical check: causal relations between factors

The relational links among three social variables, i.e. Life expectancy, Life satisfaction and Social equity are not examined. Innovation and Consumption are the focus of this study. Therefore, the correlations and causal relations between these two factors together with one of the variables are examined in order to build a theoretical model for further testing and analysis.

4.2.2.1 Consumption – Life expectancy – Innovation

Figure 4-1 Consumption - Life Expectancy Correlations (Source of data: UNDP, GFN; Figure constructed by author)



Explanations of the data: Most health data recognizes that life expectancies are largely increased by control of contagious diseases and nutrition in infants and children under 5, and that the life expectancies in non-technological societies for humans that survive past the age of 5 are as long as or longer than those in many technological societies. (Evidence of clusters of centenarians in mountain peoples in Georgia, for example, or of Tibetan monks also offers this conclusion.) The data offered here is for comparison of industrialized or industrializing societies which have conquered most infectious diseases and are seeking to prolong life through investments in health care and scientific knowledge about the human body and the environment.

Longevity does not require excessive consumption, but nutrition, good diet, healthy lifestyles and clean environment. But, do people live longer in order to innovate or to consume and enjoy life? In reality, most of the centenarians in the world are those who often lead secluded lives, not participating in technological and scientific innovations. They however consume much less than average people due to their denial of material and positional goods and because they live closer to nature. For egalitarian and agrarian societies, more spending on health care and family planning, especially to control infectious diseases would increase their average life expectancy. However, under circumstances of a stable social structure of this kind of society without interferences and control from outside over their ideologies and ownership of resources, technical innovations for survival and incremental changes (appropriate technologies) would be triggered, while no other types of innovation would be encouraged. People live longer not to innovate but to enjoy the meaning of life itself, thus will only "consume" more for cultural activities.

People would live longer in order to consume and enjoy life, so they would consume to live longer. The relation between longevity and consumption in this case is a positive feedback loop. Examples for this phenomenon are societies where there exists no control over the excessive uses of pseudo-enjoyment products and health products.

Innovation in science and resource demand for scientific research, health and education and other better public services would increase average life expectancy. However, more investment on health care products may be a symptom of an unhealthy environment caused by human activities and a wasteful allocation of resources, rather than a sign of careful "consumption" for health per se. The North American society offers a good example of this phenomenon.

Good life expectancy overshoots the global resource base: Most of the countries that achieve more than 70 years in life expectancy use resources more than the global earth share (2.2 hectares/ person) and far more than the current global biocapacity, at 1.8 hectares per person. China is the sole country in this 25-country group that consumes less than 1.8 global hectares to live longer than 71 years, but its growing economy is experiencing a rapidly higher rate of resource consumption as other industrial countries.

Longevity does not require more resources: The country that has the highest life expectancy is Japan (82 years). The countries that have similar footprints to Japan's, but that have a lower average life expectancy include Israel, Germany, France, Greece and Russia, in which Russia is the least ecologically efficient in providing long life for its people (65.3 years), almost 17 years fewer than the Japanese. There are many reasons for this dropping average life expectancy in Russia, but widespread high alcohol intake and tobacco abuse are counted as the prominent factors.

To reach to the good life expectancy spectrum, the levels of resource consumption amongst the countries are however widely varied. And the countries in this group are the most highly

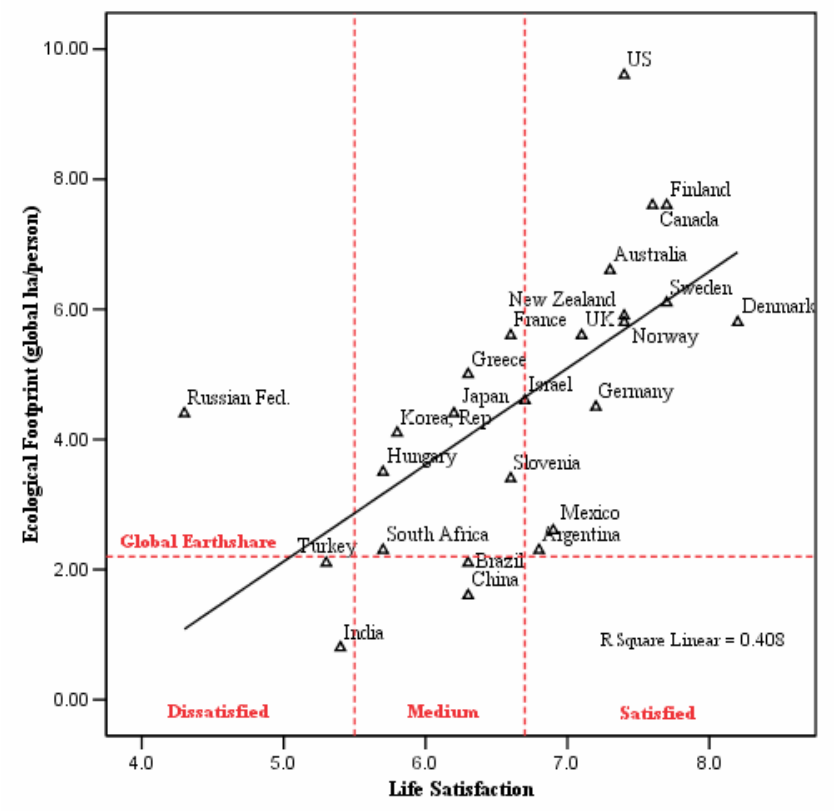
industrialized countries, with a distinctive pyramid of population structure, the aging population.

Improvements in healthcare, nutrition and changes in lifestyles are all contributing to a good, healthy and longer life. While reorganization of the healthcare system may or may not cost too much for a country to be able to serve their citizens better, the improvement of the physical infrastructure and the provision of equipment proves to be frequently expensive, especially in the complex healthcare systems. A better traffic management and provision and maintenance of well-designed road signs and lighting systems to reduce road accidents may require substantial initial investment, and high running cost. However, it is also true that the consumption of resources to produce and consume products that are harmful for human health, such as tobacco, alcohol, excessive sugar-content products, etc. may imprint the side effects of consumption on people's health.

Social conditions that create disparities in population such as racial inequality and discrimination would limit general life expectancy of a society. The disparities that persist in the population structure would hinder any improvements in life expectancy. Many scientists prove that social inequality leads to ill health, thus explains big gap in life expectancy between unequal society and more equal society.

4.2.2.2 Consumption – Life satisfaction – Innovation

Figure 4-2 Consumption - Life Satisfaction Correlations (Source of data: GFN, NEF; Figure constructed by author)



Life satisfaction is a cultural determinant, so is heavily shaped by social norms and social values in the relevant society. Self-reported life satisfaction is applicable for individuals rather than for the public in general. However, the more there are individuals expressing positive attitudes toward their life the more societies tend to be a satisfied as a whole.

In agrarian societies, low level of knowledge (education, professional skills) actually proves not influencing on one's perception about one's life. But in industrial and industrializing societies where low educational level means lower chances to find jobs or fewer good opportunities for good paid jobs, investment for education increases level of one's satisfaction with life.

Ability to control over one's health proves to be positively correlated with sense of satisfaction with life. Though once again, good health may not require more things to consume, consumption of health products and health care equipment may increase one's positive attitudes toward life.

Increase in consumption of pseudo-enjoyment and positional goods and excessive or wasteful consumption to meet basic needs may increase life satisfaction temporarily but will not ultimately improve or even reduce life satisfaction. Here to maintain pseudo satisfaction with life (for positional goods and pseudo-enjoyment) would lead to increasing demand to consume.

The causal relation between innovation and life satisfaction is not clear yet. In a society where the disparities between people are large, people tend not to be happy and satisfied especially when people compare themselves with their neighbours, friends and rich people fencing themselves in order to prevent thefts or intruders. While people also tend to compare with the standard of living of their parents, the younger generation tends to have more than their parent generation. Innovation levels in this society whether or not are triggered by disparities in income and consumption are not however clear.

The more things possessed, the more satisfied people appear: Though the correlation between these two factors is not significant, there is a trend of increasing consumption to strive for higher sense of satisfaction in life. Most of the countries are using more than the global earth share to be happy. Those countries that consume the most are amongst the most satisfied.

Possible to have a similar satisfaction level with less consumption of resources: In this group of countries, for example Sweden is consuming resources more efficiently in achieving the same level of satisfaction in life than Finland and Canada, and even experience higher level of satisfaction than Australia and the US with lower consumption. With these countries and Norway and New Zealand, Denmark is the most satisfied with fewer resources consumed.

Satisfied with life overshoots the global resource base: All of the countries satisfied with their life use more resources than the global earth share and are well above the current global biocapacity. In this comparison, the most desirable goal for humanity is to reach a fulfilled and satisfied life within the carrying capacity of the Earth, the far lower right corner in the Figure 4-2. In the current test, sustainable consumption has not yet been reached by any of the countries that are satisfied with their life. Mexico, Argentina, Brazil and China appear quite close to this goal.

There appears no strong correlation between the environmental performance of countries and their happy life years. However, there are several "traits" that can be observed to interpret the relations between resource consumption and life expectancy/ life satisfaction. The observations for this relation are presented below:

Pattern of choice – More resource consumed to trade-off with longer lives: The group of countries that consume less than 2.60 hectare/ person includes those having life expectancy of no more than 75 years. South Africa is an exception in this group with extremely low achievement in life expectancy while using more resources than most of other countries in this

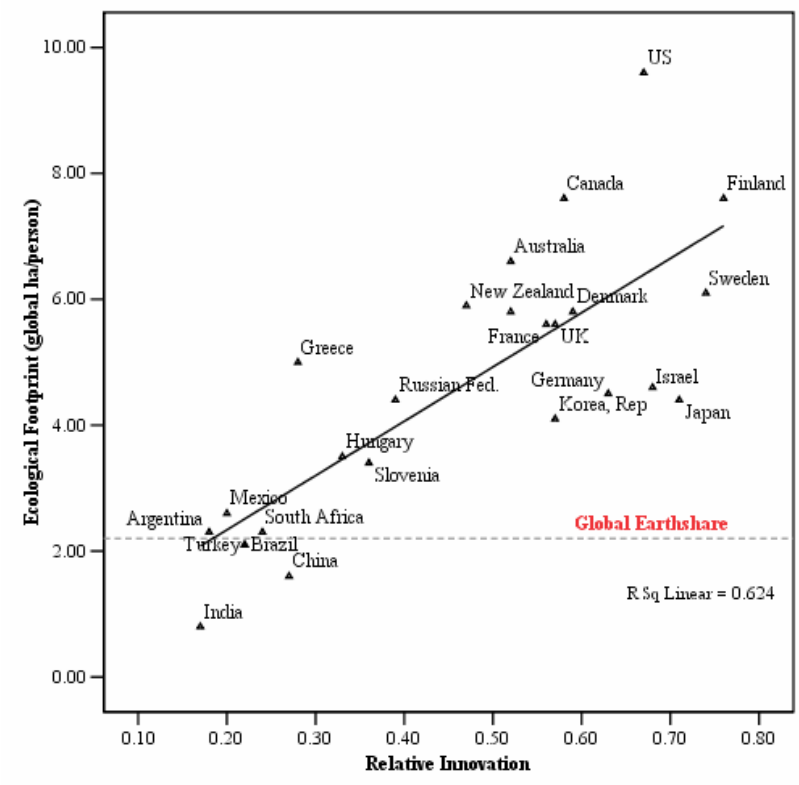
group. The "pattern" of choice in this group is that more resource consumed brings about longer lives to live. Amongst the remaining countries that have a footprint larger than 3.50 hectare/person; Hungary is catching up the good life expectancy of higher than 75 years, while Russia is performing extremely poor with 65.3 years only. For South Africa and Russia, there seems no causal relation between resource consumption and life expectancy, but other factors affecting the efficiency of the countries in providing better health condition for their peoples. The more they would consume in the future would not necessarily translate into an increase in life expectancy. It's not the economic throughput that would determine how long their people would be living and improve their life.

The reality of public and private expenditures for physical infrastructure and human resources in providing good health care systems, public spaces, good air quality, good food choices, preventative measures in medication, etc. shows that it would need more intensive resources. However, the mental health and other aspects of quality of life play important role, if not crucial, in influencing the longevity of individuals. People tend to live longer when they have positive perception about themselves, or when they are more satisfied with their lives as a whole.

Satisfaction with life may mean more than living longer and healthier. While it is widely acknowledged that self-reported satisfaction with life is largely influenced by cultural factors, the satisfaction of life expression also reflects the embedded socio-economic and political situations of individuals.

4.2.2.3 Consumption – Technological Innovativeness

Figure 4-3 Consumption - Innovation Correlations (Source of data: GFN, GIP; Figure constructed by author)



High correlation between resource consumption and global innovation performance among this 25-country group;

Wide range of resource needs for being highly innovative: According to the Global Innovation Scoreboard, clusters of countries with similar performance give more information about their innovative capacities. Accordingly, Japan, Germany, Finland, Sweden and Israel and the US are all in the same cluster having the highest innovation performance and "being the main countries pushing the global technological frontier." In this cluster of the most innovative countries, Germany, Israel and Japan use much less resource than remaining countries to pursue their high innovative capacities and technologically frontier leaders. Japan has a limited pool of natural resources, versus the US who has more relax access to natural resources, both within and outside its territory by military intervention.

France, Denmark, Norway, Canada, Republic of Korea, Australia and the UK are amongst the second best countries with regard to innovation performance. They appear to be best in innovation drivers and applications. Like the first cluster, the countries in this group use a wide range of resources to have similar performances; Republic of Korea uses almost half of what Canada uses.

Greece, Mexico, South Africa, Argentina, Brazil, Turkey, China and India are amongst the countries that have strength in innovation diffusion, and have lowest level of consumption amongst the 25-country group.

Most of the less ecologically unsustainable societies on earth are societies with low levels of technology and who are threatened by the societies that are developing new technology. The less technologically innovative countries in this 25-country group are using much less resources than the other highly innovative countries.

More innovative reduces resource demand? This is the case happening in the group of countries that have strength in innovation diffusion and lowest level of consumption amongst the 25-country group. This is also the case with Japan compared with Israel in the same group of highly innovative countries, and compared with most of the countries in the second best innovative group.

Amongst the highest innovative country group, the disparities in resource consumption may be accompanied by different rates of diffusion of green technologies and forms of innovation. Investment for the development of cutting-edge technologies, which may or may not be resource efficient would add more into the resource basket of a society, is demanding.

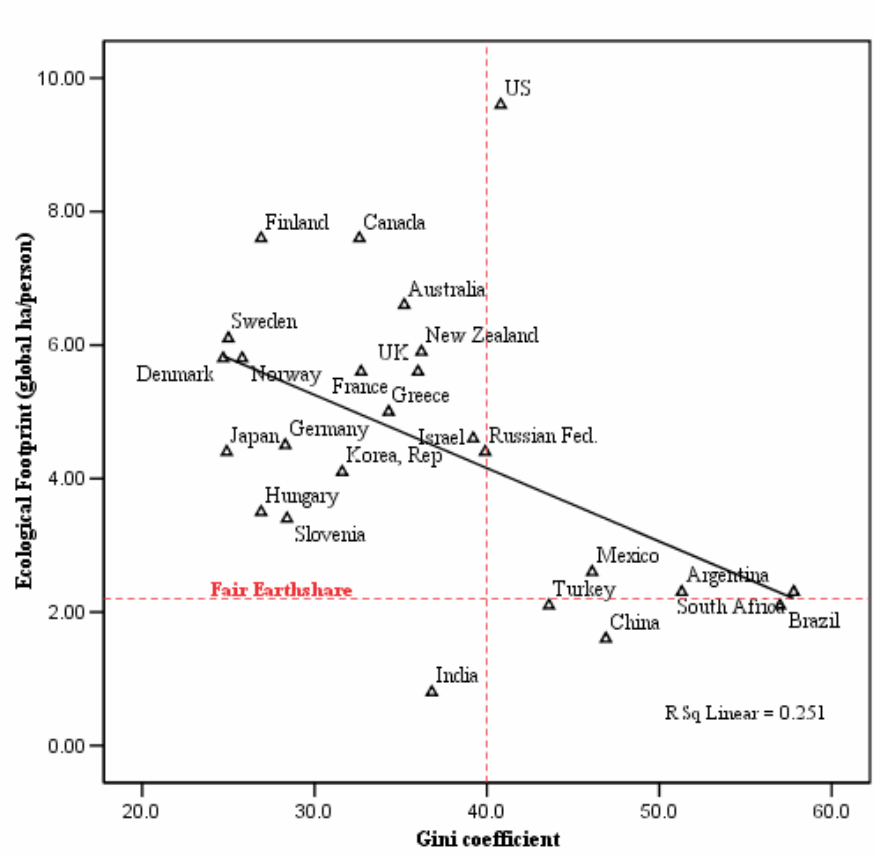
The current unsustainable consumption patterns in the most industrialized and technological countries are one of the influencing factors leading to the increasing aggregate consumption of resources that is alarming. The question now is which is the cause and which is the origin of the other, consuming more and technological progress. Does consuming more trigger more innovations or on the contrary, more innovations lead to consuming more? What type of "product" that needs to be consumed in order to retain innovation within the environmental limits? These are the key questions that are left open for further study.

Although many researchers believe that eco-innovations are often radical innovations that require changes in consumption patterns and institutional as well as organisational set-ups, most of the eco-innovations and social innovative initiatives can only bring about improvements of a factor of less than 5 (Mont, 2008), which is far below anticipated rate of changes for sustainability. As Hellstrom observed, the majority of eco-innovations will not help reach the truly sustainable emission targets at a commonly suggested range of a factor of 10-50 over the next 50 years (Hellstrom, 2007).

The current form of economic growth can hinder technological progress due to its emphasis on increasing returns to scale which reduces the rate of innovation and the rate of reduction in aggregate resource consumption in the whole economy.

4.2.2.4 Consumption – Social equity – Innovation

Figure 4-4 Consumption - Equity Correlations (Source of data: GFN, UNDP; Figure constructed by author)



The correlation between the resource demand and the achievement in social equity in countries is very weak. There is no clear pattern of whether the level of equity in the society is largely influenced by its resource demand, or whether the levels of resource consumption induce the income and wealth distribution justice in countries. Extremely high resource consumption appears attributable to other goals rather than providing better social services and social welfare for its citizens. High Gini coefficient in the US reflects a wide disparity between social and cultural groups in American society in spite of high resource demand and actual utilization of resources.

Other determinants such as working hours and social cohesion may play a role in influencing the relation between these two factors. It is well observed that when income inequality becomes wider people tend to work longer. The economy tends to be expanding and produces more goods and services because of longer working hours.

Despite the high levels of resource consumption, the Scandinavian countries and Japan appear to be the most equally distributive societies. Even though there is a wide disparity in resource inputs amongst these countries in order to achieve almost the same level of equality. Japan needs 3.2 hectares less compared to Finland but still achieves more equal level than Finland. By this comparison, it would be possible for countries to reduce their resource demands while

retaining social equality in the societies as in the case of Finland and other Scandinavian countries when compared with Japan.

Now the question becomes whether countries would reduce their resource requirement to a level lower than that of Japan while maintaining their high quality of life and social equality that as Japanese are enjoying? The example of this 25-country group cannot give an answer to this question, where the lower resource consuming countries have however the less equal level than Japan, not mentioning those countries having less equality level but using more resources than Japan.

For the two Innovation types, Organisational and Process/ Service Innovations, more innovations will lead to increasing social equity. This happens because social cohesion, social solidarity, cooperation and communitarian values are amongst the prerequisite conditions for these types of innovation to be triggered and in order to maintain the system of innovations. Furthermore, equitable distribution and equal opportunity to access to the common goods are the goals of this kind of initiative. But the causal effects of "social equity" on these two types of innovations are not clear. With regard to resource requirements for these types of innovations, original demands for mainstream consumption, which are not met/ satisfied due to disadvantaged locations or social disadvantaged position, might be high, as found in various social innovation initiatives. However, the resulting consumption patterns may be changed, at least contemporarily (but for long-term effects, there has been no study yet); and consumption of Pseudo-enjoyment, Social status, Food, housing and domestic energy and Transport may be reduced.

Technology and Science Innovations: There are two social phenomena reflecting the causal relations between innovation and social equity. (i) In the Anglo-Saxon model of society, i.e. US, UK, Australia, etc., where societies value harsh competition among individuals to get the best, the small proportion of talented and creative people are the most highly paid while the majority of the public are paid with much lower wage and by doing so, high innovation rate is maintained. So in this model of society, high innovation rate is just a symbol of high disparity in income and wealth distribution amongst individuals, but this high inequity is maintained and triggers high innovation level. In this type of society, all kinds of consumption will be increased. (ii) The other phenomenon is that more innovations are to decrease social disparity. Consumption patterns and levels in this pattern of society need to examine. If innovations are for increasing equity, investments for higher minimum education level, comprehensive social services, universal health care insurance, retirement scheme, unemployment benefits, child day care.

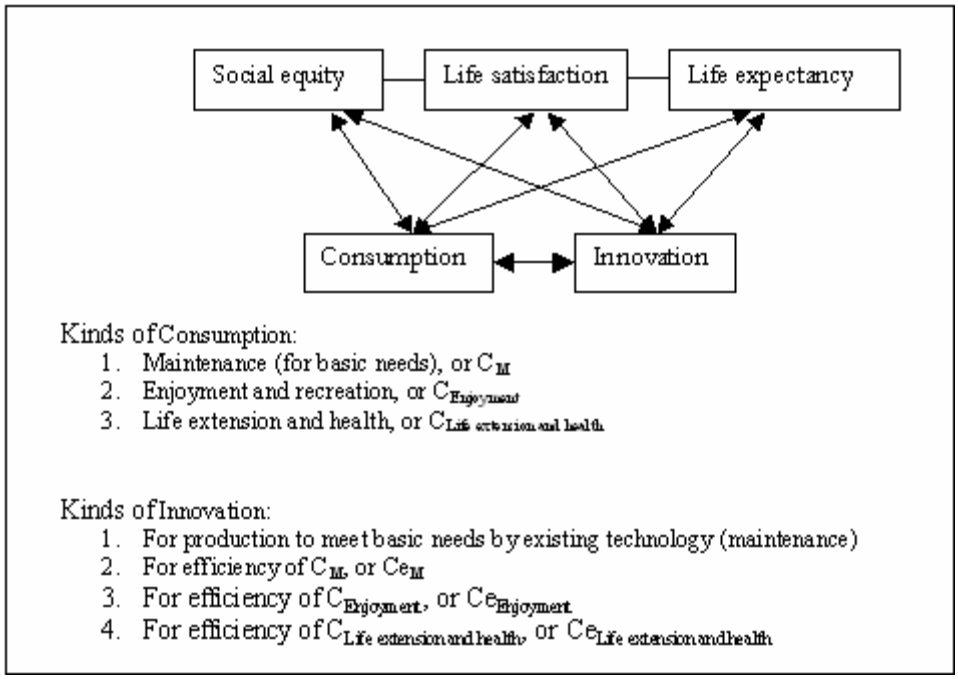
Consumption for Science, Health, Knowledge and Public transportation is expected to increase in order to reinforce and improve social equity.

4.3 Multiple Factor analysis: Theoretical Model of the Dynamic Relations and Path Interactions of the Different Variables Over Time (Social development and change)

4.3.1 Description of model: Inter-relationships of the Variables and Suggestions of the Dynamics of Technological Societies

After looking at different sources of research works in the area of this study, the interactions amongst these five factors (consumption, innovation, life satisfaction, life expectancy and social equity) are complex in determining certain paths of development that countries have been following. The Figure 4-5 below presents these complex relationships as an attempt of the author to construct those relationships in a visual presentation.

Figure 4-5 Hypothetical dynamic matrix of relations (Figure constructed by author)



Though the links and interactions between those factors are not clear or strong, an attempt to illustrate this set of relations is presented as follows.

Consumption and Innovation have direct interactions in this conceptual matrix of dynamics. For various kinds of consumption, the resulting effects on different kinds of innovation may be observed. Examples include increased innovation for production to meet basic needs by existing technology to basically maintain life will lead to increased consumption C_M. Or increased investment for efficiency of production for life extension and health (increased $Ce_{Life\ extension\ and\ health}$) will result in increased consumption for extending life and improving health, or $C_{Life\ extension\ and\ health}$. But whether this increase in $Ce_{Life\ extension\ and\ health}$ would lead to an increase in C_M and/ or $C_{Enjoyment}$ is conditional and dependable to other social factors and cultural choices. And here at this point, social preferences may play an influencing role in directing and shaping the choices of technologies/innovations and consumption.

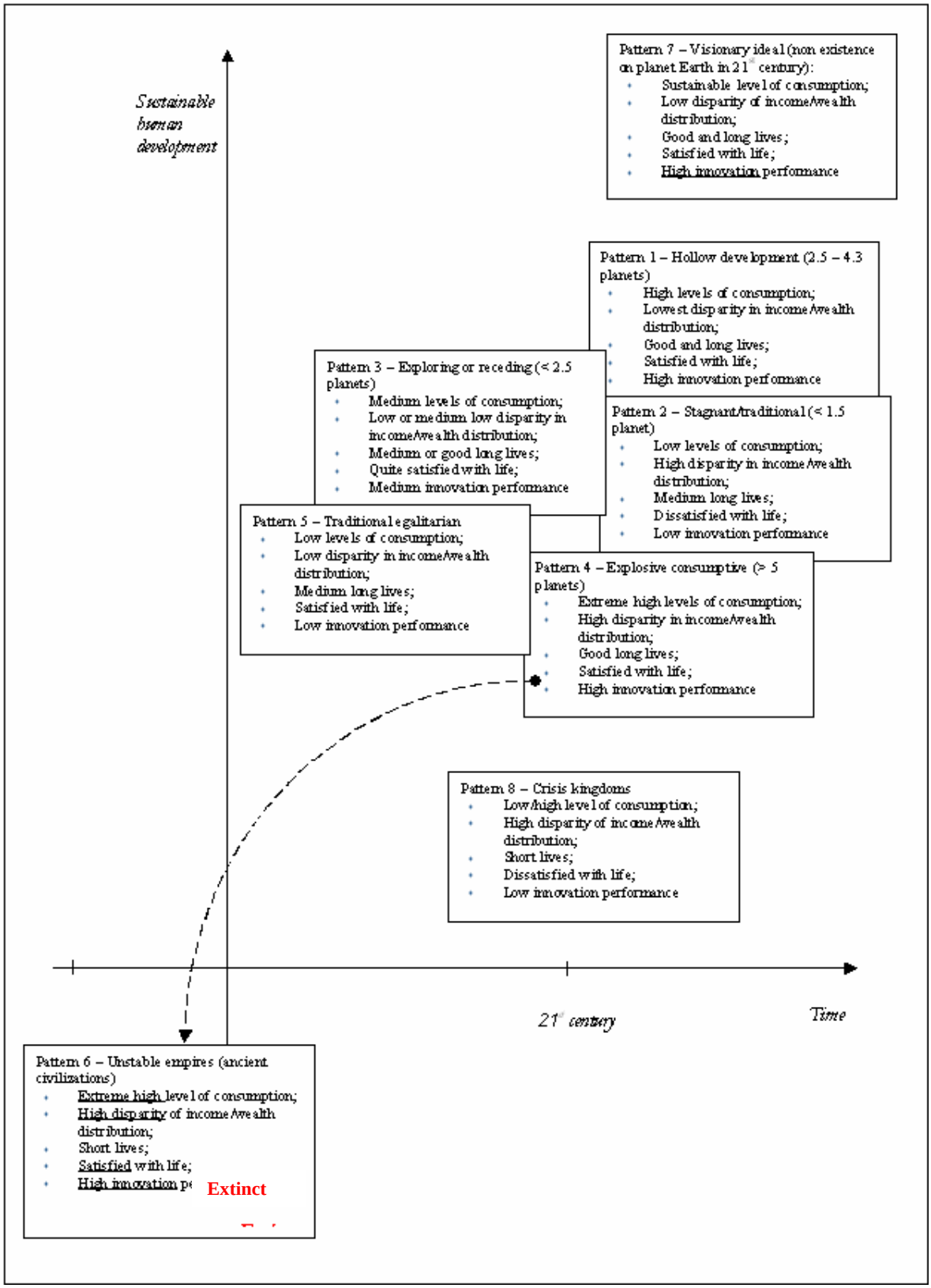
4.3.2 Interpretation of Clusters and Suggested Categorizations of the Different Countries as a Prelude towards Examining Potential Pathways of Change and Development

4.3.2.1 The Patterns Observed in the Data

By using K-Means Cluster analysis technique, the number of clusters of similar societies was pre-determined by the author based on the similar patterns of relationships between variables in pairs. Analyses of 4 clusters and 5 clusters were giving rather close results regarding groups of societies that are least different on the basis of 5 selected variables. For the results of 4-cluster and 5-cluster analyses, see Appendix 3a. Report on Multi-variable Cluster analysis: Results for 4 clusters, and Appendix 3b. Report on Multi-variable Cluster analysis: Results for 5 clusters.

From the data and the correlations between the five selected variables together with observations in the history of human civilizations, the patterns of development for existing and extinct societies are presented in the Figure 4-6 below.

Figure 4-6 Hypothetical archetypal paths of development: Extinct, Existing and Visionary Ideal (Figure constructed by author)



Examples of Pattern 1 – Hollow development include high-tech countries, i.e. Scandinavian countries, Japan, Germany, etc. These pattern type societies can be grouped into two sub-clusters, in which one that have low disparity in income and wealth distribution. Examples of this sub-cluster include Scandinavian countries, Germany and Japan. The other that has

medium high disparity in income and wealth distribution includes Anglo-Saxon societies and the like, i.e. UK, Australia, Israel, New Zealand, and France.

Pattern 2: Examples are low-tech countries, i.e. Latin American countries, India, Turkey, Greece. South Africa is an exceptional case where in all the Cluster analyses run, it was the only society that has specific pattern significantly different to others.

Pattern 3 comprises "catch-up countries" like Hungary, Slovenia, and also "receding countries" like Russia who used to be highly innovative in cutting-edge technologies and who is experiencing declining health and life conditions.

Is pattern 4 the worst case existing? In both 4-cluster and 5-cluster analysis, the US was belonging to group of either Scandinavian countries or group of Anglo-Saxon cultures. However, the distances of the US case to the centre of the cluster are significantly large compared to other cases in the same clusters. It is the extreme high levels of consumption of the US society that differentiates it from others. Also for the emphasis of the global environmental sustainability, the US is a prominent case that deserves to be placed as a complete pattern on its own.

Pattern 5 is the pattern of traditional egalitarian societies that exist in fact but not in the database. They include indigenous groups who lack statehood and protection.

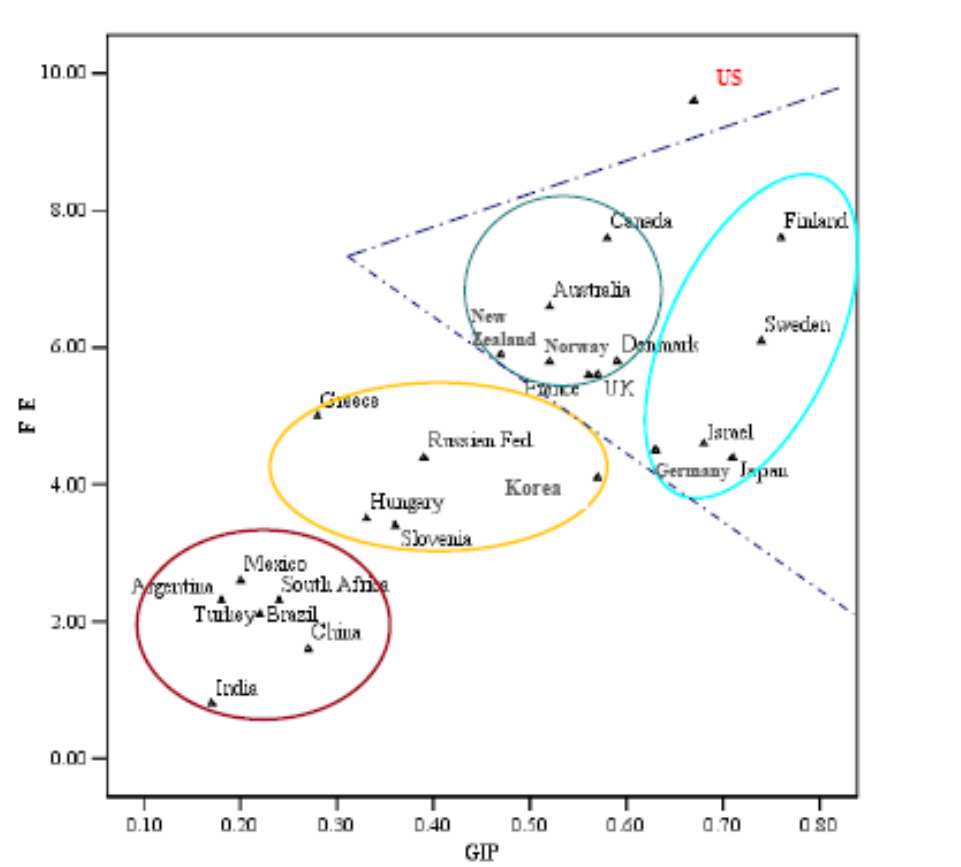
What significant in Pattern 6 – Unstable empires (ancient civilizations) is that this pattern can arguably be phase two of pattern 4 – the Explosive consumptive societies. What is different in societies that follow pattern 6 and those that follow pattern 4 is the extension of life and health conditions that these two types of societies (have) experienced. When the health conditions deteriorate and actually decline in the pattern 4 societies, those societies are on the brink of "explosion".

The Visionary ideal society is non-existence on planet Earth in the 21st century. Pattern 8 – Crisis kingdoms, which are not in the database but existent in reality, e.g. Myanmar, Zaire, Haiti.

For a table of description of the patterns, see Appendix 4. Table of Hypothetical archetypal paths of development: Extinct, Existing and Visionary Ideal.

The following figure shows the clusters of similar patterns of the existing societies. The two sub-groups belonging to the same cluster (pattern 1 "Hollow development") are grouped but also placed in the same triangular. The US is a separate "cluster" which is close to the pattern 1 cluster in this figure.

Figure 4-7 Clusters of similar development patterns (Source of data: GFN, GIP, UNDP, NEF; Figure constructed by author)



4.3.2.2 Dynamic analysis: Hypothetical archetypal paths of development: Existing, extinct and visionary ideal

The dynamics of various paths of development depend on the interactions between various factors and variables. In the archetype of "Unstable empires" that are extinct, increased pressure on continuous innovation of new technologies to meet increased demand and consumptive needs was driving the ancient civilizations towards increasing gaps in wealth distribution, resource allocation and access among various social classes, creating conflicts among various resource users. The sudden drop in health conditions and the appearance of infectious diseases caused by the collapse of the local environment led these unstable empires to their end of existence. The earlier stage on the path that these ancient empires had taken exemplified the pattern of the "Explosive consumptive" group of societies.

For the "Explosive consumptive" archetype, consumption and social inequity are requirements for innovation, and vice versa, innovations bring about more things to consume and reinforce the disparity between various ethnic, cultural groups and social classes in the society. This type of society seeks for more resources even outside its boundary for the sake of continued innovations for leading technologies. Only a small segment of population experience longer life while a larger part of the population may experience declining health conditions and a drop in life expectancy. Increasing income while increasing relative income disparity makes people feel less satisfied and insecure.

The "Hollow development" archetype is moving towards increased innovation in technological change and increased consumption. New technologies help extend life and

improve health and may further bring about increased equity if priorities for social issues are placed within innovation and technological policies.

In the "Visionary Ideal" type of society, innovation is subject to be high and interactive, while consumption reaches sustainable levels within the local resource and environmental limits. A happy, satisfied, healthy and long life is the goal of this type of society. When the society moves toward sustainability, its population gets more innovative, experiences equitability and life longevity.

The pattern 3 comprises two paths of choices: the Exploring path and the Receding path. The common dynamic may be that of increasing consumption in both two paths. But the dynamics of the other four factors appear divergent as shown in Figure 4-8.

Figure 4-8 Hypothetical dynamics of archetypal paths of development (Figure conceptualized and constructed by author)

Archetype	Innovation	Consumption	Satisfaction	Equity	Longevity
Hollow development	↗	↗	Stagnant or declining	? ↗	↗
Stagnant/Traditional	↘	→	↘	↘	? ↗
Exploring	↗	? →	? →	↗	↗
Receding	↘	↗	↘	↘	↘
Explosive consumptive	↗	↗	↘	↘	Conditional
Traditional egalitarian societies	Indigenous groups that lack statehood and protection; They are either assimilated into dominant culture, thus actually culturally extinct, or their innovation capacities never have chance to develop and flourish.				
Unstable empires	Ancient civilization; Extinct				
Visionary ideal	→	Sustainable levels (subject to slight fluctuations but not beyond limits)	Happy and Satisfied	↗	→
Crisis kingdoms	-	→	↘	↘	↘

Note: The arrows shown for the Equity column are actually representing the Yes/ No answer for the "socially equity" aspect of each type of archetypal society. The upward arrow equates to "Yes, this type of society has equity", while the downward arrow means, "No, this type of society is not socially equitable". Social equity is an absolute concept in itself, meaning that either society has it or not, but it cannot be relatively measured on a gradual scale.

4.4 Theoretical and Policy Implications of the Visible Clusters of Technological Societies

The major difference between the existing patterns of development and the visionary ideal archetype is the DIRECTION of technological innovation development. My main argument here is that technological progress should not be served as an end in itself but as a mean to achieve human progress and development. It should thus be directed towards human sustainability. As a rule, market orientation of innovations favors incremental improvements that solve immediate problems and which are assessed as bringing in fewer financial and organisational risks as well as guaranteeing a relatively shorter payback time with benefits largely driven by private interests. Solutions to immediate problems are determined and dependent on the systems in place, both technological and institutional, while the advancement of technologies cannot be predicted until a new technology is placed in use. But for the visionary ideal archetype of a "good" society, purposes and applications of technological improvements are envisioned to reflect the common interest of the society at large. In relation to natural resources, any projections of technological innovation progress would serve to keep the sustainability equation in balance or in other words the stability between consumption and production.

The major difference between a "good" society, that is technologically innovative and sustainable, and an unsustainable society lies in the capacity and determination of that society to PLAN for sustainability. Results of creativity and innovativeness are fruits of logical and rational thinking, in trying and testing all possibilities to solve a problem. Societal and systemic problems are different from sectoral and immediate problems in the fact that the goals of solving them need to be clearly stated and in consistency.

The data suggests that "free trade" and globalization actually limit the possibilities of sustainability for societies and for the humankind by limiting the number of innovations in other fields of knowledge and expertise even in industrial societies, and at the same time limiting the number of innovations in non-industrial societies that have not been locked in the paths dependent on modern technological systems that have been chosen and reinforced by industrial societies. Globalization is an attempt to reach a global agreement on sets of common standards that are aimed at maximizing the compatibility of systems. This is an attempt to limiting the number of innovation pathways through the use of standards and pre-shaped ideologies of human development.

5 Testing of Theoretical Models - Case Study Comparison of Choice in Similar Environments: Sweden and Denmark

This chapter offers a comparison of choice in similar environments: Sweden and Denmark are chosen for the model testing. Thought experiment and path analysis of social choice are the two methods that are used for the testing.

5.1 Hypotheses for Qualitative Testing through Case Studies

From the models and analysis in the previous sections, there are four static patterns of development but may be five dynamic "paths" of development amongst this 25-country group as shown in the Figure 4-6, Figure 4-7 and Figure 4-8 of the previous chapter.

The focused patterns and paths in this study are those that have high innovation performance, namely the "Hollow development" group and the "Explosive Consumptive" group. They are currently the societies that consume the highest quantity of the Earth's resources for development, far beyond the regeneration capacity of the Earth. A path on which a culture favouring and encouraging highly innovative development is upheld at the cost of unsustainable levels of resource demand is a blind path. Humankind would destroy its own home and source of life - the earth and its life-support systems before another alternative would have been found possible and feasible.

My hypothesis is that technologically innovative societies are locked in their blind path of "market-oriented" innovations. Innovations driven by the market and for the market needs will end up with meeting new consumptive demands and new types of exploitation means of common goods. There is a clear link between the expansion of economic activities and the levels of economic competitiveness at global market. When innovation performance is measured to estimate how much is an economy's potential to produce goods and to dominate a certain segment of global market outweighing other economies, market-oriented approaches in enhancing innovation capacity and performance appears a push factor that leads a society to a blind path of increasing production and consumption in order to feed in the machine of ever expanding and more complex technological systems.

5.2 General description of the cases

Sweden and Denmark are selected for the testing of the hypothetical models developed in the previous section of this paper, for a number of reasons. Both the two countries are all in the same archetype of development, the pattern 1 – "Hollow development" as categorized in the previous chapter. Both Sweden and Denmark are amongst the model countries of equality for their universal welfare systems (Scandinavian welfare model), their relatively high standard of living and relatively high technologically innovative level. Both of the countries have highly integrated into the globalisation process, placed amongst the highest urbanized and industrialized countries in the world, of more than 80% of population living in urban areas (Nordic Statistics Yearbook 2007).

Given the similar geographic and climatic conditions of the North Sea, Denmark and Sweden have the same concern over the global environmental issues and the trans-continental consequences of environmental problems.

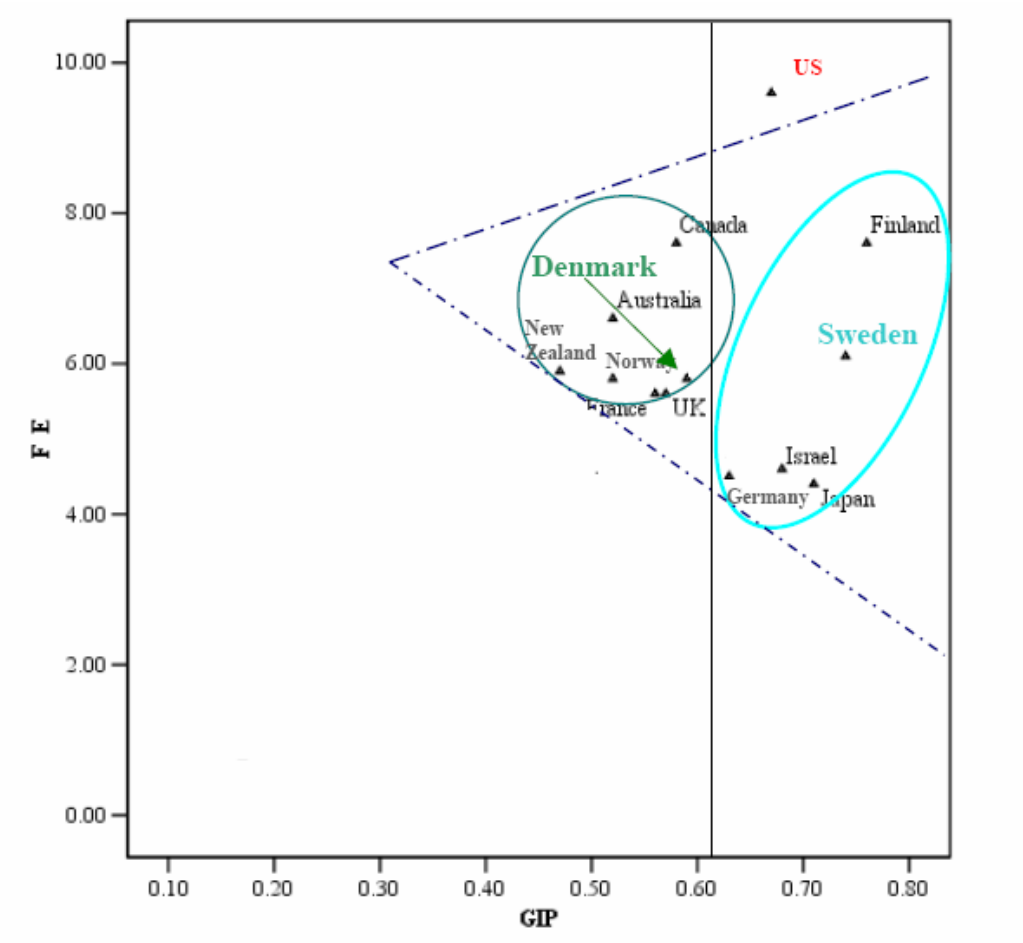
An economy of scale is the common characteristic of both Danish and Swedish economies. Like other European countries, historically, economic activities, trading expansion and maintaining and strengthening inter-regional trading networks have been always main revenue

to wealth in European countries. Agricultural produce and territories are no longer the resources for wealth of a country as a nation state. Examples for this among others are shipping industries and trading activities both in Denmark and Sweden that became fully flourished during the second half of the 19th century and the first half of the 20th century. In modern time, the trading ties and relationships between these two Nordic countries with foreign counterparts in business have been intertwined and weaved in such a complicated manner that it becomes challenging to identify what products are purely produced domestically without raw materials or components imported from outside.

However, there are some distinctive differences between these two neighboring societies that share many common cultural and historical features. Denmark has a denser population distribution, six times higher than in Sweden.

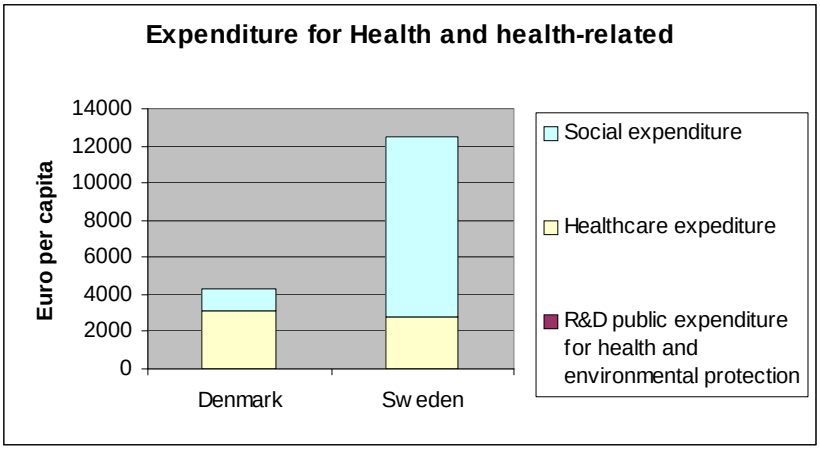
Although Denmark and Sweden are grouped in the same cluster of Pattern 1, they belong to two distinctive sub-groups that have some different characteristics in development patterns. In the case of Denmark and Sweden, it is their different focuses and performance levels of innovation that differentiate these two neighboring societies. Sweden is in the group of the initiators of edge-cutting technologies, while Denmark is amongst the countries that are specialized in technological applications and low-tech development. The other characteristics in their development paths are currently rather similar (in static manner).

Figure 5-1 Why Sweden and Denmark are two interesting cases (Source of data: GFN, GIP, UNDP, NEF; Figure constructed by author)



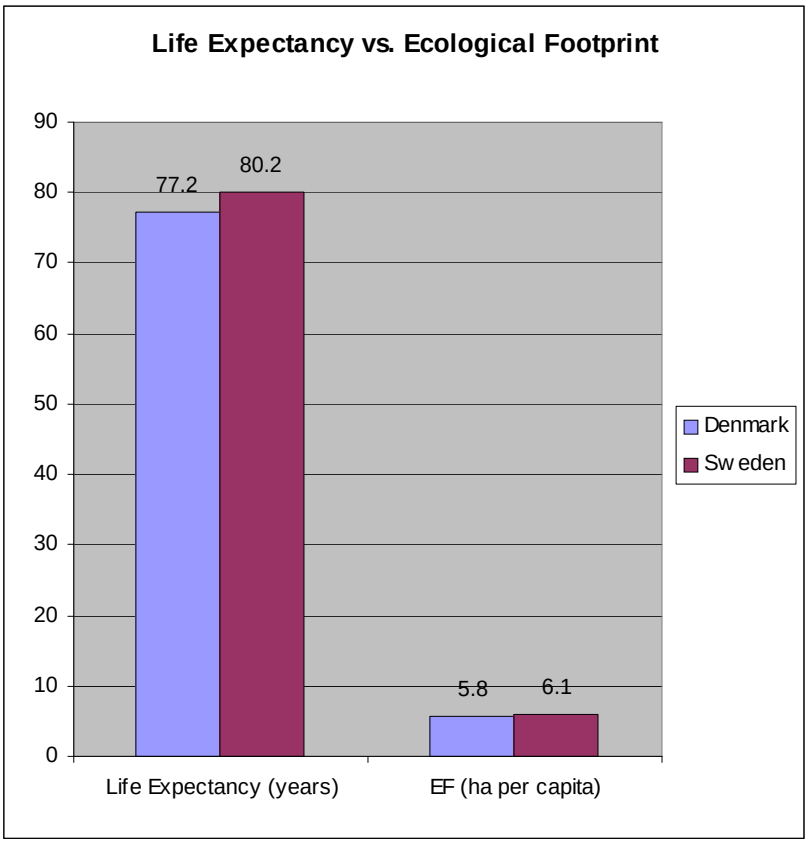
Sweden annually spends 12,000 Euros per capita on health and health-related issues while Denmark spent only one-third of that for the same objective. More investment and expenditure have been spent per person in Sweden than in Denmark. To what extent this has a direct effect to the longer average life expectancy in Sweden is another issue, but Swedes have a life expectancy of three years longer than that of the Danes.

Figure 5-2 Expenditure for health and health-related: Sweden and Denmark



Source of data: Nordic Statistics Yearbook 2007

Figure 5-3 Life expectancy vs. Ecological Footprint: Sweden and Denmark



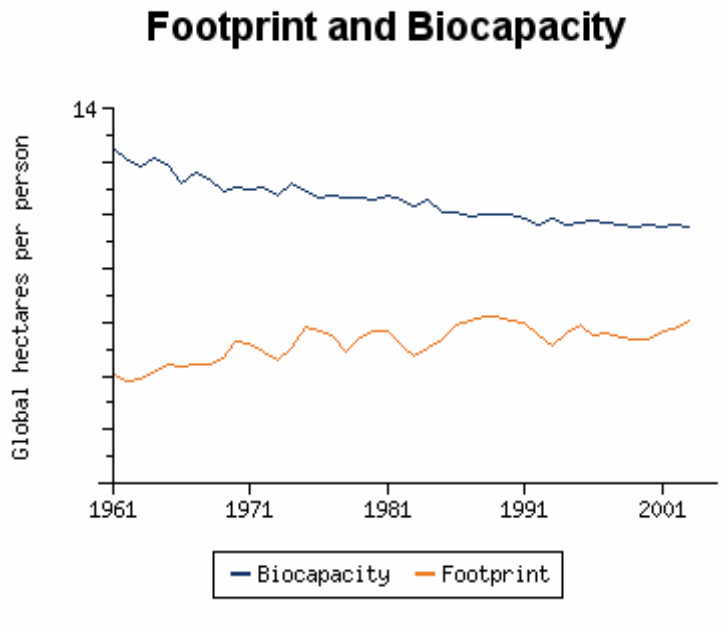
Source of data: Life expectancy (2007) from UNDP; Ecological footprint (2006) from Global Footprint Network

Some of other significant differences in the choices made in the two countries are presented in detail below.

5.2.1 Sweden

Regardless of a "fair Earth share", Sweden is ecologically sustainable within its biocapacity (GFN 2008). According to the Global Footprint Network (GFN), at the current consumption rate (data in 2003) in the country, each Swedish citizen uses 6.1 ha of productive land for consumption and waste absorption (Ecological Footprint) while the biocapacity of the country is as much as enough to provide 9.6 ha of productive land equivalent per capita (GFN 2006). The high efficiency realized by its world-leading technology base largely explains why Sweden is currently able to ecologically "sustain" its high level of resource consumption. Sweden's ecological footprint has been increasing though and its ecological surplus has been tightened over the last 43 years (from 1961) (GFN 2008). With a growing economy and increasing consumption levels, the question is how long Sweden can be sustained within its ecological constraints and to what extent of affluence the country can sustain its people given its seemingly favourable advocacy of technological fix to free itself from ecological limitation.

Figure 5-4 Ecological Footprint and Biocapacity of Sweden 1961-2003



Source: Global Footprint Network, 2008

Yet, in the global context, it is a moral question when looking at the fact that Sweden's per capita footprint is three times larger than the world average (2.2 hectares), and that the country is consuming more than three times as much of the "sustainable fair Earth share" (1.8 hectares per person), when the country still depends on the health of the common good – ocean and air, and imported goods including food in exchange of technologies that the country exports. Even though the country has remained a net export country mainly of technologies and timber products, 40% of the country's foodstuff is imported (Nordic Statistics Yearbook 2007). And the country has also been at risk of increasingly high concentration of acidifying substances emitted from car use and industrial activities, experienced air pollution in cities and urban areas as well as increasing number of environment-related health problems. Although

Sweden is not in the same situation with most of industrialized countries that have far overshot their biocapacity, the country has been facing the same question of balancing its production and consumption of resources within its carrying capacity in the long run to achieve a livable and viable future.

When dealing with the phenomenon of high level of resource consumption, Sweden tends to move further into the modernization process integrating "economic criteria of quantity" and "ecological criteria of quality" by largely relying on technological innovations and efficiency factors that are believed to help ensure increased and continued economic growth.

Sweden's private consumption expenditure contributes up to 47.3% of GDP in 2006 (Nordic Statistics Yearbook 2007). Food consumption is of 12% of private consumption expenditure, while expenditure for housing, water, electricity, gas and other fuels for household consumption is the highest contribution, 28%. Swedish people spend 13.2% of their total expenditure on transport (Nordic Statistics Yearbook 2007).

More than half of the land area is covered by forest, and 38% of arable land is used for grain production mostly for livestock farming (Nordic Statistics Yearbook 2007).

5.2.2 Denmark

As in Sweden, Denmark has hardly any wild nature but plantation forests outside its densely populated urban areas. 65% of Denmark's total land area is cultivated or zoned as gardens and parks. While Sweden is dependent on hydropower and nuclear power for energy, Denmark's major energy source is from thermal power generated from coal, oil, and gas. Therefore, Denmark is the only country in the Nordic region of which emissions generated from energy production are of high concern, as much as compared to other industrial countries of the same size. Denmark however is in a lead in the world in developing and exporting wind technologies such as wind turbines and windmills (Nordic Statistics Yearbook 2007).

5.3 Results of the testing

Testing the hypotheses into the two case studies of Denmark and Sweden within a short time with a limited number of samples of interviews and observations is not sufficient for the researcher to come to any firm conclusion. The hypothetical model is also subject to be tested in a broader context. However, the researcher of this study tries to present the main findings as an initiation for further discussions.

In static patterns, the two societies appear to have very similar choices with regard to social preferences, i.e. welfare benefits and social policies in a universal welfare state model (which is reflected in decisions on ensuring a least disparity in income and wealth distribution, a high level of satisfaction with life and good health conditions as a basis for high average life expectancy). The two societies also have rather similar perspectives toward the roles of innovations toward sustainability – an emphasis on economic motivations for technological innovations. Although there appears a small divergence in the dynamics and trajectories of development between these two societies, whether these two societies are diverging into two different paths toward development is not addressed yet in this study. Denmark appears to move toward ICT-based society and chooses low technologies to develop as its economic strength and to tailor its demands on resources for its own growth and development (resource accounting). Sweden chooses a path to develop high technologies as its major competitiveness in the international marketplace and positions itself as highly innovative in the international marketplace for war materiel production and export.

The hypothesis is proven to stand, that technological innovative societies like Sweden and Denmark are locked in their path of "market-oriented" innovations, which seems a blind path under the current ideology of infinite economic growth model. Below are the discussions of the test in details. The sources of data are mainly primary data withdrawn from interviews and field visits that the author has carried out during the period of January to May 2008. The interpretations and analyses are of the author.

5.3.1 Technology-dependent economy requires high concentration of resources

Complex technologies, which are products resulting of diverse scientific and engineering knowledge and capabilities across various organisations, are knowledge and learning intensive, which requires knowledge bases, skills and capabilities of scientific and engineering expertise. Networks linking organisations, vertically across the supply chain, i.e. supplier-producer relationships or horizontally across sectors and fields of expertise, i.e. strategic alliances or joint venture, are evolving innovative networks that grow into more complex structures and employ complex processes. The complexity of technologies requires complex networks of relationships among organizations of various specializations. Examples of complex technologies that are dominant export products in Denmark and Sweden include telecommunication equipment in Denmark, and telecommunication equipment and automobiles in Sweden.

Complex technologies and high-technology-dependent systems require a complex systemic structure, both institutional and organisational, to support and retain the system itself. Complexity of institutional and social organisations, especially the robust social service and welfare systems in Denmark and Sweden, as well as higher requirements on quality and infrastructure for education and training requires more resources to sustain the operations of these systems. Denmark and Sweden are in the lead in using modern information and communication technology, both in business sector and private individuals.

The establishment of ENIS network – a platform for integration of information technology in schools, and digital schooling project in Denmark are examples of a "top-down" approach to respond to the complexity and demanding requirements for changes of education infrastructure and knowledge base. The "education of scale" that has been observed in Denmark's primary and lower-secondary schools exemplifies the Danish perspective toward integration of formal education into the complexity of technologies to prepare Danish children with knowledge of modern techniques and modern technologies that are presumed essential for the Danish competitiveness. Computerized curricula, teaching-learning experience with extensive networking and ICT-intensive knowledge sharing systems increases resource demands for establishing, maintaining, and collaborating within and among networks as well as managing the systems. While Southern Sweden's primary and lower-secondary schools, ICT has been part of the education where school children learn how to use computer and its basic applications as part of their learning experience with information technology.

Super specialization in economic activities also leads to a diversity of specialized products and services. Service industry has contributed over two thirds of Gross Domestic Product (GDP) in Denmark and Sweden as in other industrial countries, and is expected to be a rapidly growing sector in the coming period when private industry and public sector have been increasingly outsourcing support functions in their attempt to focus on core competencies. Sweden is also a highly sectoral specialized economy.

National innovation systems are the intertwined linkages of previously distinct institutions, e.g. government institutions, business sector, universities and research institutes. The development

and investment for such national innovation system, similar to the national network of innovation actors for economic growth, is well established in industrial countries. In Denmark, the national innovation system is managed under the Ministry of Science, Technology and Innovation, but in Sweden the government has set up a separate institution, the Swedish Governmental Agency for Innovation Systems (VINNOVA) to "promote sustainable growth by funding needs-driven research and developing effective innovation systems" (VINNOVA, 2008).

Sweden's small primary industries are also highly technology-based, considered as among the most technologically advanced in the world. Examples include mines, paper mills and steelworks. Remote-controlled machinery would mine as twice ore as much with only half as many employees (VINNOVA website).

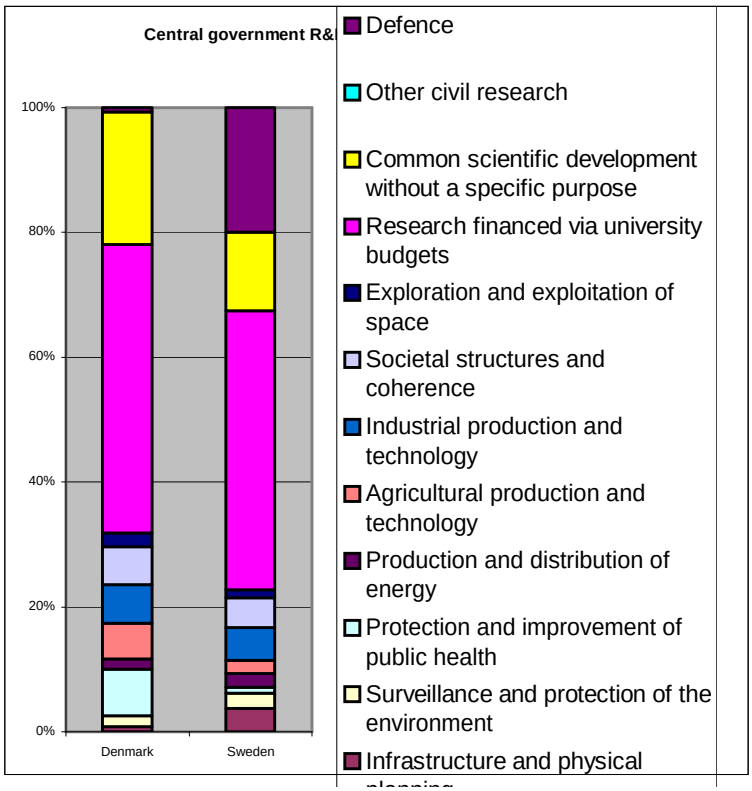
5.3.2 National security and military industry matter

Does concern over national security play any role in the development of technologies and innovations, which in turn affects the levels of resource demand of a society? When it comes to the national security and military industry, Denmark and Sweden are in two different situations and approaches. Denmark is a member of the NATO while Sweden is holding its non-aligned and neutral position in this issue by not joining any military alliances. Denmark imports most of its military materiel from other NATO member countries and Sweden. Because of its non-aligned position, Sweden has its own war materiel industry that is considered as world class in technological competence.

Figure 5-5 shows that 20% of total R&D expenditure by Swedish government was spent in 2005 for defense objectives, second largest spending allocated just after that for research financed via university budgets. In Demark, much less than 1% of the central government R&D expenditure was allocated for defence research.

Increase in non-civilian innovations in the military industry with loose regulations on exports of arms products is most likely leading to rapid increase in production of the materiel and therefore leading to an increase in resource demand for the production. Though the Swedish armed forces have recently been downsized due to budget cuts, the military industry of the country has had an increasing proportion of its income generated from arms materiel trade and export. Sweden is now considering exporting security products as a potential for economic growth of the country.

Figure 5-5 Central government R&D expenditure by objectives (2005): Sweden and Denmark



Source of data: Nordic Statistics Yearbook 2007; Figure constructed by author

The observation here is that Sweden has chosen to be self-reliant in defense materiel and equipment, which requires the country to devote a certain amount of its resources for this purpose. Hence, if the military industry of the country is not discouraged to increasingly export arms materiel to the world market due to its high competence in technologies and economic competitiveness, more resources would be used up to feed this industry.

5.3.3 Internationalization of innovations under globalization scenario reinforces the positive feed back loop of innovation and consumption

Path dependence would be more reinforced due to increased time pressures and intense competition that create an environment where incremental innovations are focused just to solve immediate problems, thus disfavoring sustainability issues which do not appear economically pressing but fundamental for the integrity and progress of humankind.

Multinational companies spend high investments for R&D to maintain the rate of innovations and high performance in business competition. Thirty-five percent of companies in Sweden are multinationals. Most of them are foreign-owned and have branches in other industrial countries and emerging economies. Companies tend to outsource their investment for R&D to various locations that have strong competence of relevance and knowledge base as a response to the changing environment of business and investment. This is also a challenge in Sweden as of how to maintain this high investment when these companies may invest in other countries, outside Sweden for its R&D activities. Private-public partnerships are promoted in Sweden as a response. Position of multinational companies and high R&D intensity in Sweden has been stimulated by long-term public-private, user-producer relationships based on technology-intensive public procurement by public monopolies or semi-monopolies.

According to the Swedish national agency for innovation systems (VINNOVA, 2002), the Swedish public service sector is large, by international standard. Public procurements that are in favour of technological innovations are actually a push factor in technological change and influence in turn social preferences toward technological solutions and innovations.

Buying intellectual properties and merger are considered as practices of open innovation. Multinationals reinforce their innovative capacity not only by investing in their internal R&D capacity but also by buying off its smaller competitors. Swedish multinational corporations are adopting the same strategy.

5.3.4 Market orientation of innovation policy may hamper sustainability solutions

This study confirms that environmental care in companies' activities, even in their innovation programmes, is ultimately instrumental. Thus work on environmental issues and environmental care-laden innovation programmes become a means of attaining a company's goals. Environmental laws and regulations play as the minimum line for compliance. Consumer's and customer's environmental concerns may play a stronger role in determining the environmental performance of companies since the companies all pay highest attention to market-based adaptive management of production and innovation.

In terms of market orientation of innovations and the issue of resource allocation and prioritization of societal needs, both Denmark and Sweden consider themselves as small countries and because of that they believe that they have to trade in the international market in order to survive.

Public-private partnership is a tradition in Sweden, and a success factor in the prosperity of the country. Since the middle of the 1990s, there has been a shift in this tradition, i.e. public-private partnership has shifted to public -private-university partnership, the so-called "triple helix" in the national innovation system. Schools including universities and higher education institutions are entity that designs and implements models that facilitate change in various environments. While companies and industries are pursuing instrumental rationality in their activities, the question now becomes how to make these entities adopt both value rationality and value-instrumental rationality in their actions (of production); if the triple helix relationship does not turn universities into business-type institutions, this would abandon or weaken their role of change facilitator.

The role of government's public funding is important for start-up companies, particularly with provision of financial, infrastructure and networking support in order to keep their innovative research continue at the beginning phase of the establishment (to stabilize their adoption and prevent discontinuance). However, for start-up companies, commercialization of their products at the first stage is reasonably placed at a higher priority compared to continued research and development. The role of the government in this case for example is to create intent to change.

Environmental innovations, or innovations for the environment in the business environment, are very broad and there is a tendency of perceiving cost-reducing adaptations and adaptive technical changes as eco-innovations.

High dependence on existing technological "paths" that aim at "growth" cannot decouple the technological progress and resource consumption. Vicious circle of "technocratic fix" is that the government expresses a need for continued economic growth to invest in green technologies to reduce economic activities' impacts to the environment. While the re-allocation of budget funds to "green" economies is more important and plays a decisive role in

directing the focus of the economy, there is an argument that this is the transition towards a green economy in which there are still "grey" economic sectors that "generate" returns large enough to support or subsidize greener activities.

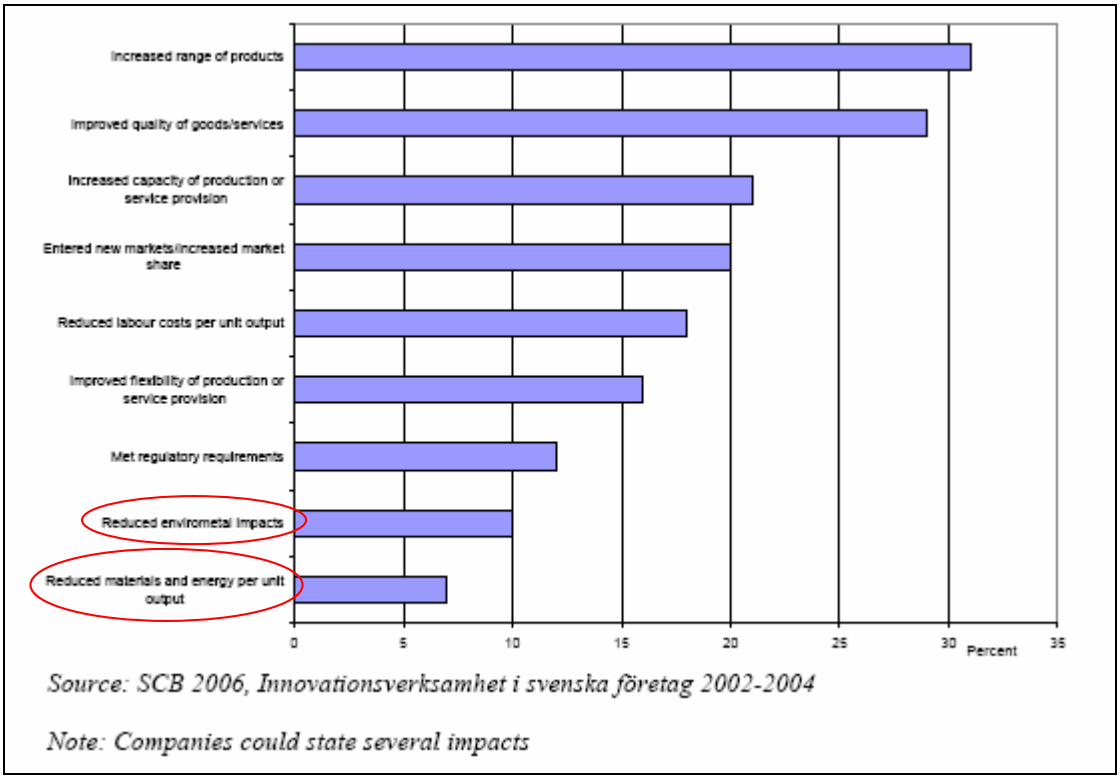
Denmark has a weak capacity of curiosity-driven research and innovations (Danish Agency for Science Innovation and Technology, 2007). The country has a very weak research base for space programme, and other scientific research or basic research, mostly applied research. Sweden is considered as lacking strategic research (Benner, 2003).

For Sweden, the phenomenon of the flows of immigration of Swedes to North American from 17th century until early 20th century was an example of Swedish culture's view towards choices of development. There were various reasons and factors contributing to the flows of Swede immigrants to North America and Australia during that time: Economic opportunities, religious and political motivations, but most determinant reason was "**overpopulation**" in Sweden by that time. The introduction of potato and smallpox vaccine in the early 19th century helped reduce the death rate and accelerate the population growth in a country where not much of land fertile for crops was available. Crop failures in the period of 1866 and 1888 were considered as the direct push factor resulting the mass immigration flows of Swedes to America in the years between 1888 and 1889 (Donlan, 2003).

Over the past decade, Sweden has undergone changes in entrepreneurial culture where companies, including foreign-owned Swedish companies and multinational corporations, focus more on building their relation with stockholders rather than with stakeholders and communities as what Swedish companies traditionally did (Geer, Borglund, & Frostenson, 2003).

Market-oriented innovations in Sweden for the period of 2002-2004: about 31% innovative companies stated that their innovations were introducing new products, increased range of products, then improved quality of goods/ services (29%), increased capacity of production or service provision (21%), entered new markets/ increased market share (20%), reduced labour costs per unit output (18%), improved flexibility of production or service provision (16%), met regulatory requirements (12%). The least proportion of innovative companies listed environmental impacts of their innovations, i.e. reduced environmental impacts (10%) and reduced materials and energy per unit output (7%).

Figure 5-6 Proportion of innovative companies in Sweden that stated each of the impacts of innovations launched 2002-2004



Source: (Norgren et al., 2007)

For most of the industries, the most significant impact of being innovative is their increased capacity of production and service provision. This means that more goods and services are produced and provided to the market, both domestic and international.

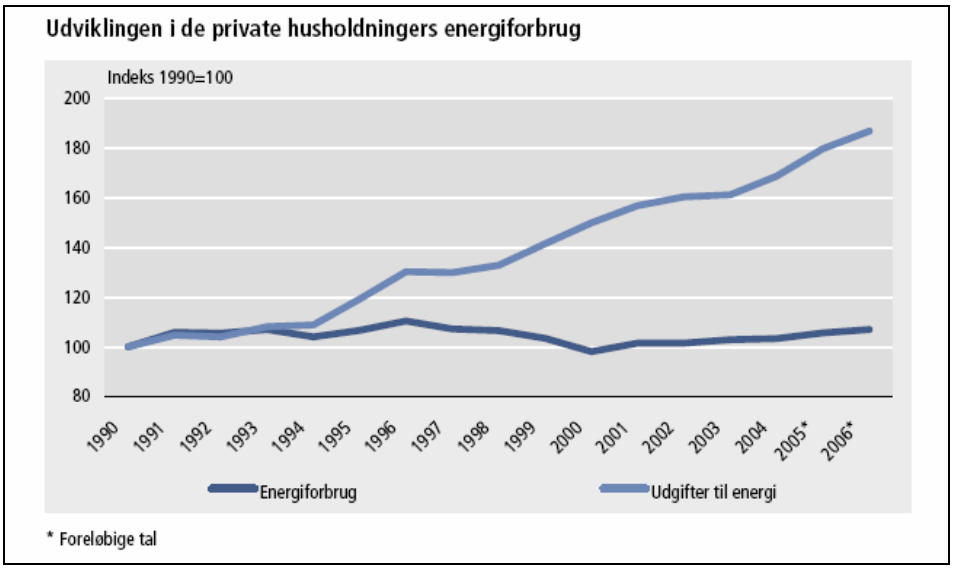
Social welfare researchers consider environmental taxes in Denmark as the only evidence of the linkage of welfare policies and environmental concerns with regard to resource utilization and environmental quality. When asked whether there has been any attempt in linking environmental issues, particularly those of resource consumption, with welfare objectives in research and policy analysis at central government and research centres in this field, the interviewees only pointed out this weak linkage in current welfare research, directing to only environmental taxation as a mean to improve environmental quality as part of the general objectives in securing social welfare in this broad sense. However, when environmental tax is discussed, there always is discussion about the competitiveness of the economy, the exemptions and rebate schemes, which are arguably increasing the social costs to achieve a given environmental target.

In Denmark, increased environmental concerns from environmental groups and left wing party, 1990s – currently; "green" tax reform was introduced mainly to compensate revenue loss induced by reduced income tax rates; this lead to a widespread expectation that if people really react to some environmental taxes by reducing their consumption levels, green taxes would just be raised again in order to recover the revenues lost. Green tax reform's main objective was fiscal objective - revenue compensation to a shift in income taxation scheme (reduction in income taxation). There have been times when the environmental taxation scheme was criticized as bringing about socially adverse effects (2001 Social Democrats' were criticized by the Liberals as "red" taxes to raise revenue for the expanding government budgets).

It appears that the Danish government has taken a more coherent approach to structural changes in economic and welfare policies. Coalitions among varied actors of various policy areas of employment, welfare and economics are established and strengthened. Benner viewed this as one of success factor, a systemic policy on growth and innovation in the Danish model (Benner, 2003).

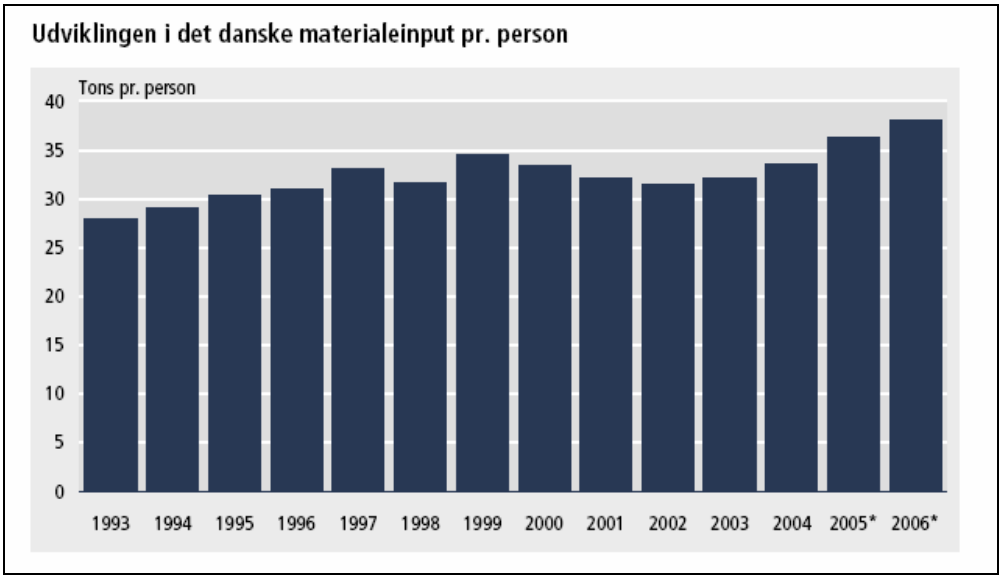
The Danish government has taken sequential steps of radical reforms of growth policies: monetary policy, then industrial policy, followed by labour market policy and recently research and innovation policy. The aim of these radical reforms is to establish new growth paradigm while still retaining the fundamentals of the traditional welfare model. However, consumption content remains intensive in energy and material as shown in Figure 5-7 and Figure 5-8. Material inputs have still been increasing over the last 15 years in Denmark despite of increasing efficiency and growing rate of technological innovations.

Figure 5-7 Energy consumption Denmark 1990-2006



Source: Danmarks Statistik 2007

Figure 5-8 Material input Denmark 1993-2006



Source: Danmarks Statistik 2008

There appears a strong political support of a well further integration into globalization in Nordic countries, as the leaders of these countries acknowledged and emphasized that they are "prime beneficiaries of globalization". To integrate deeper and to ensure its competitive advantages, the fundamental tiers of Scandinavian welfare model are re-examined for the sake of economic growth and prosperity: High taxation of labour and the compression of wage differentials across skill groups, the two characteristics of the Scandinavian welfare state model that is to guarantee the region's generous welfare benefits and least disparity of income groups, are increasingly considered as problematic for its economic competitiveness, especially for economic growth.

Economies that are catching up are considered as a challenge for the Nordic competitiveness. There seems a shift in strategy, from attract foreign capital to attract human capital in these aging populations.

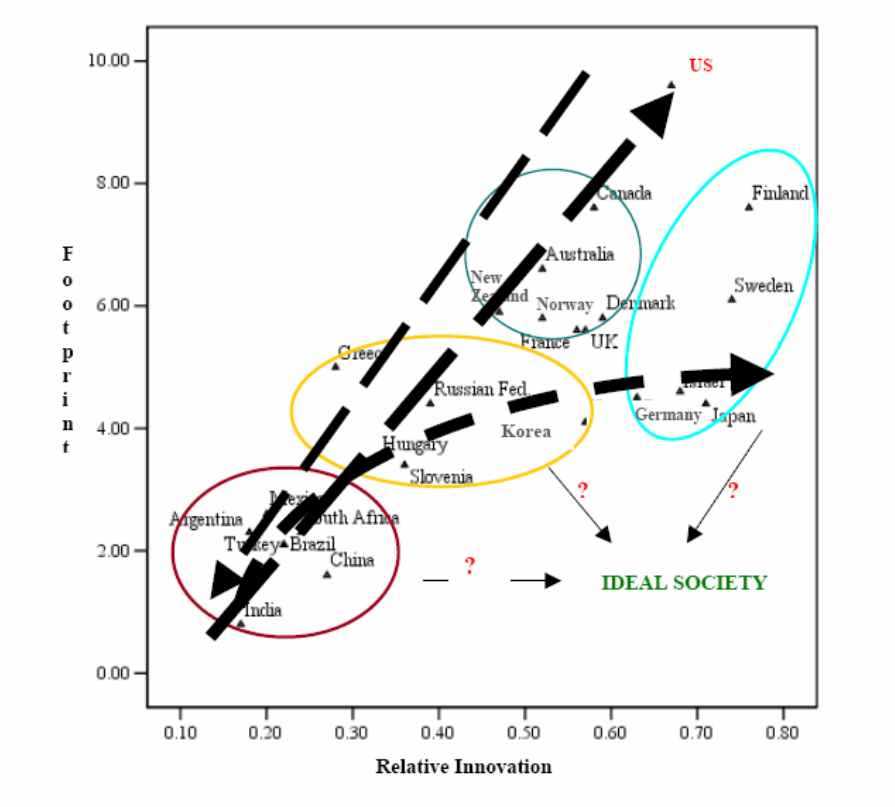
5.4 Thought Experiment and Path Analysis of Social Choice

All the existing societies would need to make fundamental changes and adaptations in order to be able to move toward the ideal type of society. On the graph illustrated in Figure 5-9, the ideal society is at the lower right corner that exemplifies an equitable, happy and healthy society with high innovation performance, low (or sustainable) levels of consumption. The most challenging situation would be for the "Explosive consumptive" type of society to transition toward the ideal society. Eliminating the military industry and transforming the war economy into peace economy would significantly reduce high levels of consumption in this type of society and its followers.

The constraints to a transition for other industrial societies may include their current ideology of infinite economic growth and the long-lasting assumption and belief in a positive correlation between increased income and life satisfaction, as well as the current political choices amongst political parties.

Societies may have different preferences for the development. But the planning capacity and determination in balancing the resource base within a society's natural boundaries would be the first step toward planning for a good list of preferences and priority of actions and programmes to transition toward the "good society".

Figure 5-9 Dynamics of development paths (Source of data: GFN, GIP, UNDP, NEF; Figure constructed by author)



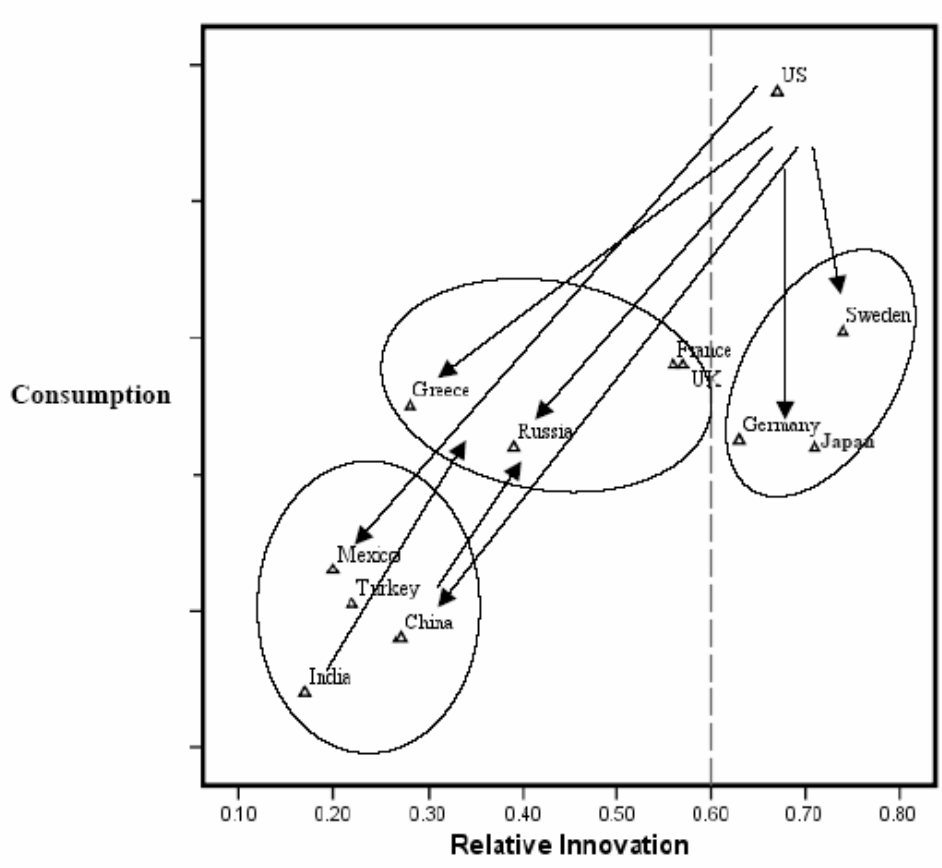
The Figure 5-10 presents a selection of those countries that used to be world empires or currently "empires" that have had ambitions to conquest and gain access to resources outside their natural boundaries. In the figure presents the current "positions" of those societies in relation to relative consumption and relative innovation with others. However, there must have been transitional paths on which these societies have been moving along from a "position" in the past to the current one.

For the "Old world empires", i.e. Aztec – Mexico, Ottoman – Turkey, Old China before the 13th century, and Old India before the 6th century, they were highly innovative and progressive in new technologies, as well as vastly exploited resources (and even by conquests) to meet increasing demands for inserting power and influence in the respective regions. These empires should have been somewhere on the top right corner near the US, which represents high consumption levels and high levels of technological innovation. Why and how "these old world empires" have slid down on the scale of technological innovations? There can be a vast range of reasons and factors explaining this phenomenon in these old world empires. Growing populations and being colonized are amongst these reasons. Due to lack of adequate investment for science and technological projects, these countries have not been able to expand its scientific and technological base. China has been planning for its population growth with "one-child" policy since the 1960s and is currently investing more to improve its science base and technological capacity, under its ambitious policies for economic growth and gaining its scientific excellence. Which path the "old world empires" would take, the same path as the "new disintegrating empires", namely the US and Russia for example, or the other path that the "shielded former empires", i.e. Germany, Japan and Sweden have been following, or other different paths, depends on their motivations and political choices. Barriers for those "old world empires" to transition towards the ideal society include the globalization forces and the standard model of economic growth.

New disintegrating empires, the US and Russia, are following different paths. Russia in the 1960s was amongst the leading powers in developing new technologies and highly innovative compared to other countries in the world by that time. High spending on military research and development and a dependence of scientific and technological progress on the progress made in the war materiel industry in both Russia and US during the Cold War were significant factors that kept these countries on the top of the list of highly innovative countries in technologies and science. Among other factors, it is the closeness of the society and the brain drain of Russian scientific researchers that led to the decline in the innovative capacity of modern Russia. Social welfare and health conditions have also declined in transitional Russia.

For Germany like other European countries, it was the Marshall's plan after the World War II that helped the country to rebuild a new society. It was not only physical infrastructure and but also culture that have undergone major changes. Economic recovery, not military reinforcement, was the major plan. Japan was in the similar situation after the Second World War with financial support and being put under the American military umbrella that this country focused and allocated its resources for economic recovery. These countries have been "shielded" or controlled under the US military influence, which led these countries to economic investment rather than developing military base. Similarly, Sweden of the 17th to 20th century chose economic development and non-alliance in military activities.

Figure 5-10 Hypothetical dynamics of paths (Figure conceptualized and constructed by author)



5.4.1 Suggested Testing of Hypotheses on Other Countries

The above hypotheses about various motivations that societies would take in order to move along a given path could be tested on other countries.

Japan, identified as being in the pattern 1 – "Hollow development" type of society, would be tested with the following hypotheses:

- The Japanese culture that values a slower speed in life appreciation would be contributing to their value toward health and social solidarity.
- The lack of natural resources within its natural boundaries would be a push factor in the high efficiency of Japanese economy.
- Under the shield of American military, Japan was able to invest for its economic recovery and development after the World War II and it was a good start of a dynamic toward more efficient economy.

6 Discussion: A Model for Transition to the "Ideal" Innovative Society

The issue of overconsumption and searching for a sustainable future for the humankind within the environmental limits is really not an issue of when and how human beings reach the level of consumption where there is a saturation of wants and material desires. It is more a question about whether a society has the capability and the determination to plan for a sustainable future with clear and measurable goals.

The innovative capacity of individuals and organisations cannot be measured as their capacity to economically outperform others (as the current innovation indices do now), but rather by their ability to use their innovativeness to reach culturally tailored sustainability.

What is a reasonable level of technological growth given the "short" lifespan of the Earth and current environmental outcry? Technological induced models in relation to resource consumption should be placed in the pathway to sustainability. For technological progress and innovations, there is a need to take risks and try new things, but the question is how much risk and what is the safe level that a society and humankind as a whole can actually sacrifice. Examples of the technological development within sustainability are various. Is nano-technology a solution? Are nano-particles a hazard? The properties of nano-particles, including their minute size, high specific surface area and special arrangement of their atoms, give nano-particles a great potential for new and cutting-edge areas of application; but these may also bring about undesired effects in people and organisms. This has been identified as still a big gap in our knowledge concerning environmental and human health hazards. Furthermore, conventional methods of assessing toxicity and hazards do not work for nano-particles. Thus they still pose environmental risks that we may not be aware of, or know how to deal with. Another example includes high level of mercury in new energy-efficient light bulbs that may have some adverse effects on the environment and human health, despite the advantage of the new technology in cutting down electricity consumption. Another example may be the diesel cars that have been encouraged in Copenhagen by tax reduction due to the technology's lower carbon emissions than oil-based vehicles, but lacking filters actually emit a larger total amount of other air pollutants posing health hazards (Tan, 2008).

The main characteristic of the current economic model is its assumption of unlimited resources and the great potential and capability of technologies in producing more with less in environmental-friendly ways. Although there was some time in the history when warnings of the scarcity of some resources were proved to be too pessimistic, there has been abundant evidence in real life showing that resources are running out at a quicker pace than actually replenished and/ or transformed. However, the growth model that most of the countries are pushing high up in their agenda still dominates and is justified as one that will bring about employment and welfare benefits.

The benefits to the universal social welfare system in a country are the most determinant factor. This is not a good indicator to monitor the level of exhaustion of natural resources internally available due to the ease of access to world resources elsewhere due to free trade and globalisation.

How can the relationship between production and consumption change? Should we have to have plans for production that in turn shape our consumption demands and patterns? What is the role of government in planning for sustainability? Should there be goal-oriented policies? And in that case, what goals should a society strive for and trade off, and how to get consensus?

"Free market" mechanisms do not internalize environmental externalities yet. Therefore the free market system is not expected to be capable to direct solutions to a sustainable nature within the desired time frame. The free market system does not care about the wants and needs of the future generations, nor for the spatial allocation and distribution of natural resources. There is however another opinion about free trade and globalization in Nordic countries, who consider themselves as the prime beneficiaries of globalization.

7 Conclusion and Recommendations for Research and Policy: The "Good" Society

7.1 Principal findings

To answer the main research question, sustainable consumption in industrial societies is impossible within standard models of growth because the approaches that are being taken to investments in growth (in new technologies) are linked with and dependent on increased consumption as a requirement of innovation and as part of ideology in societies. Industrial countries are locked into a situation that may be able to change but certain ideologies of continued and "infinite" economic growth in the realities of production and political choices currently prevent it from doing so.

From the analysis of the various sets of international data, the study has identified four main patterns of development for existing societies, two for other societies that exist but are not included in the database of the study, one pattern of the extinct empires and the "visionary ideal" archetype of society.

- Pattern 1 – Hollow development: High innovation performance, high levels of consumption, high satisfaction with life, least disparity in income contribution, and high average life expectancy;
- Pattern 2 – Traditional stagnant: Low innovation performance, low levels of consumption, high disparity in income/ wealth distribution; medium long lives, and dissatisfaction with life;
- Pattern 3 – Exploring or Receding: Medium innovation performance, medium levels of consumption, low or medium low disparity in income/ wealth distribution, medium or good long lives; quite satisfied with life;
- Pattern 4 – Explosive consumptive: High innovation performance, extreme high levels of consumption, high disparity in income/ wealth distribution; high average life expectancy and satisfaction with life;
- Pattern 5 – Traditional egalitarian: Low innovation performance, low levels of consumption, low disparity in income/ wealth distribution, medium long lives and satisfaction with life;
- Pattern 6 – Unstable empires (ancient civilizations, extinct – and this is the phase 2 of the pattern 4 societies): High innovation performance, extreme high level of consumption, high disparity of wealth distribution, short life expectancy and satisfaction with life;
- Pattern 7 – Visionary ideal (non-existence on planet Earth in 21st century): High innovation performance, sustainable levels of consumption, equity in income/ wealth distribution, good and long lives, and satisfied with life; and
- Pattern 8 – Crisis kingdom (not in the database but existent in reality, e.g. Myanmar, Zaire, Haiti): Low innovation performance, low/ high levels of consumption, high disparity of wealth distribution, short life expectancy and dissatisfaction with life.

From the case studies of Denmark and Sweden, where hypotheses were tested, the main findings are below:

- Statically, the two societies appear to have very similar choices with regard to social preferences, i.e. welfare benefits and social policies in a universal welfare state model (which reflects in decisions on ensuring a least disparity in income and wealth distribution, a high level of satisfaction with life and good health conditions as a basis for high average life expectancy).

- The two societies also have rather similar perspectives toward the roles of innovation toward sustainability – an emphasis on economic motivations for technological innovations.

- Although there appears a small divergence in the dynamics and trajectories of development between these two societies, whether these two societies are diverging into two different paths toward development is not addressed yet in this study.

- Technology-dependent economies require a high concentration of resources not only because increased consumption is a requirement for continuous innovations but also due to increasing trade activities.

- Internationalization of innovations under the globalization scenario reinforces the positive feed back loop of innovation and consumption.

- Market orientation of innovation policy may hamper sustainability solutions.

- Military industry that is competing for competitive advantages in exporting war materiel is actually a player that would keep consumption increasing.

A good society that can be best imagined in our modern time should be a society where people live as healthy and as long as the Japanese (average 82 years and more), are as satisfied with life as the Danes, enjoy the social equity as the Scandinavian citizens, are relatively innovative at technology as the Finns or Swedes and lastly consume within the equal earth share of 1.8 hectares per person.

7.2 Recommendations for Policy and for Research

7.2.1 For Policy: Mission changes for Governments

It is important to reposition the fundamental role of government in facilitating the process of identifying social needs and planning for a sustainable future; not as matchmaker only in linking the business community with the academic one based on the free trade ideology. Ministries and national agencies that promote trade should be replaced by other planning agencies that promote innovation and technologies on the basis of balancing national assets rather than seeking out resources outside the national boundaries to meet domestic needs and boost infinite growth.

In order to correctly reflect level of innovation of a society, there are more aspects of innovation that need to be measured. Supplementary criteria to evaluate the level of innovation of a society need to cover social innovation and innovations in other aspects of humanistic development.

We need to have an economic viability index (rather than economic competitiveness index as currently used). Economic viability index would measure the economic well-being as well as the long-term continuation of an economy with the inclusion of more indicators of social innovations and appropriate technologies.

Similarly, there is a need to have a Gross Domestic Consumption (GDC) and to start using it in place of GDP. It now seems more important to monitor how much a society consumes rather than how much it produces as compared with other societies. Consumption is a good indicator of how well a society is moving along the sustainability pathway and how much it is conserving.

Local economies and decentralization of power are vital for the sustainability of the humankind on earth. Globalization is really global competition for resources. Security fears over a high likelihood of a country's resources being exploited by more developed countries under free trade regimes and globalization would be a major source for maintaining and investing in military and armed forces as well as for the exploitation of resources at higher rates.

7.2.2 For Research: An Expanded Agenda for Environmental Economists

Further research needs to be done in the areas of national security and global threats to national security with regard to resource exploitation both from multinational corporations and military aggressive agents and within national powerful parties and organisations.

Given the narrow definition of innovation in this study, the correlations between consumption and other factors such as life expectancy and broader defined innovation also need to be further studied.

Environmentalists and those who work with environmental issues and sustainability need to further work on the economic equation of Gross Domestic Product (GDP) (GDP = Consumption + gross Investment + Government expenditure + (import – export)), in which an increase in other "investment" would be factored in the equation to make the society better off in the future and not only increase in private consumption. Private investment or spending for human development would contribute to the increase in human well-being. Furthermore, with respect to resource consumption, the deductions of "export" out of the production (and consumption) equation by "import" just in monetary values are not sufficient to reflect the true exploitation of natural resources of an economy. The monetary values of different goods and services as well as of different materials and resources are not equal, thus the export or import values are not the same even when the equivalent amounts of money appear the same. We need another method of calculation for actual consumption of resources in a given society.

There is also another interesting question that has emerged during the research and that is not yet answered within the scope of this study but is important to better understand the impacts of technology upon human societies. The researcher calls it as "law of technology" if there is proven to be such a "law": It seems that technological progress makes people have more time; consumption may be the pitfall of having more time and the need to occupy ourselves. So, does technological progress keep people consuming or does it keep people working?

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Abbreviations / Acronyms

C_M or $C_{Maintenance}$	Consumption for maintenance (to meet basic needs)
$C_{Enjoyment}$	Consumption for enjoyment and Recreation
$C_{Life\ extension\ /(and\ health)}$	Consumption for extending life and health
$Ce_{Maintenance}$	Efficiency of production to meet basic needs
$Ce_{Enjoyment}$	Efficiency of production for enjoyment and recreation
$Ce_{Life\ extension\ and\ health}$	Efficiency of production for extending life and health
Y	National Income
C	Consumption
G	Government/public expenditure
I	Public and private investment
$I_{Innovation}$	Investment for Innovation
EF	Ecological Footprint (global hectare of productive land per capita)
Gini (coefficient)	Gini index measuring the levels of equity/disparity in income and wealth distribution in a society
ICT	Information and Communication Technology
R&D	Research and Development
HPI	Happy Planet Index
GIP	Global Innovation Performance
Fair Earth share	Fairly distributed average global hectare of productive land per capita (in this study, it is 2.2 hectares per person). It is different from biologically available fair Earth share which is of 1.8 hectares per person currently.
GDC	Gross Domestic Consumption
GDP	Gross Domestic Product
VINNOVA	Swedish National Agency for Innovation Systems
GIS	Global Innovation Scoreboard
UN	United Nations
UNDP	United Nations Development Programme
OECD	Organisation for Economic, Cooperation and Development
NEF	New Economics Foundation
GFN	Global Footprint Network
HDI	Human Development Index
NATO	North Atlantic Treaty Organisation
Danmarks Statistik	Denmark's National Statistics
US	United States of America
UK	United Kingdom
NZ	New Zealand
Korea Rep.	Republic of South Korea

Appendix 1. People and organisations in contact

No.	Institution/Organisation	Persons interviewed
1	Det Nationale Forskningscenter for Velfærd The Danish National Centre for Social Research (SFI)	Jakob Nørgaard-Petersen Researcher
2	Det Nationale Forskningscenter for Velfærd The Danish National Centre for Social Research (SFI)	Mads Jæger Senior researcher
3	Department of Social Science, Roskilde university of Copenhagen	Professor Bent Greve
4	Copenhagen of Business School	Johannes Mouritsen Associate Professor, Engineering Economics System
5	Copenhagen of Business School	Finn Valentin Professor
6	Copenhagen of Business School	Edward Eli Director of CBS Junior Consultants
7	A.P. Møller – Mærsk	Rasmus Folso Senior General Manager Deputy Head of Innovation
8	Tetra Pak	Thomas Waldner Manager, Consumer Concepts
9	Alfa Laval Corporate AB	Nilsson Mats Head manager of R&D Department in Lund
10	Astra Zeneca AB	Per Persson Site Manager of AstraZeneca Lund
11	Zemission	Anders Vestin Founder and CEO
12	Bioprocess Control AB	Dr. Jing Liu Head of R&D
13	Department of Psychology, Lund university	Farida Rasulzada, PhD
14	Palettskolan, Lund	Agneta Thilander Rektor (Head master)
15	Palettskolan, Lund	Ann Olsson Teacher
16	Palettskolan, Lund	Hector Ericsson Artist, handcraft tutor
17	Fagelskolan, Lund	Kerstin Holmquist Rektor (Head master)
18	Apelskolan, Lund	Birgitta Holmberg Administrative manager
19	Lerbackskolan, Lund	Ann Marie Elias Rektor (Head master)
	National museum of Denmark	History museum of Lund
	DIY shops and Bookshops in Copenhagen and Lund	Museum of Art and Design, Copenhagen
	Design museum, Copenhagen	

Appendix 2. Country data used for model development

Country	*EF*	*HDI*	*HPI*	*GIP*	*Gini*	*ZEF*	*ZHPI*	*ZGIP*	*ZGini*
Argentina	2.30	0.869	52.0	0.18	51.3	-1.05646	1.48856	-1.41665	1.53360
Australia	6.60	0.962	34.1	0.52	35.2	0.95718	-0.81583	0.32094	-0.11863
Brazil	2.10	0.800	48.6	0.22	57.0	-1.15012	1.05472	-1.21223	2.11856
Canada	7.60	0.961	39.8	0.58	32.6	1.42547	-0.08203	0.62758	-0.38545
China	1.60	0.777	56.0	0.27	46.9	-1.38426	2.00738	-0.95670	1.08206
Denmark	5.80	0.949	41.4	0.59	24.7	0.58255	0.12910	0.67869	-1.19618
Finland	7.60	0.952	37.4	0.76	26.9	1.42547	-0.39100	1.54748	-0.97041
France	5.60	0.952	36.4	0.56	32.7	0.48889	-0.51201	0.52537	-0.37519
Germany	4.50	0.935	43.8	0.63	28.3	-0.02622	0.44193	0.88311	-0.82673
Greece	5.00	0.926	35.7	0.28	34.3	0.20792	-0.60342	-0.90560	-0.21099
Hungary	3.50	0.874	37.6	0.33	26.9	-0.49451	-0.35495	-0.65007	-0.97041
India	0.80	0.619	48.7	0.17	36.8	-1.75890	1.06502	-1.46776	0.04556
Israel	4.60	0.932	39.1	0.68	39.2	0.02060	-0.17086	1.13864	0.29186
Japan	4.40	0.953	41.7	0.71	24.9	-0.07305	0.16772	1.29196	-1.17565
Korea Rep.	4.10	0.921	39.0	0.57	31.6	-0.21354	-0.17987	0.57647	-0.48808
Mexico	2.60	0.829	54.4	0.20	46.1	-0.91597	1.80140	-1.31444	0.99996
New Zealand	5.90	0.943	41.9	0.47	36.2	0.62938	0.19604	0.06542	-0.01601
Norway	5.80	0.968	39.2	0.52	25.8	0.58255	-0.15670	0.32094	-1.08329
Russia	4.40	0.802	22.8	0.39	39.9	-0.07305	-2.27057	-0.34343	0.36370
Slovenia	3.40	0.917	44.0	0.36	28.4	-0.54134	0.46768	-0.49675	-0.81647
South Africa	2.30	0.674	27.8	0.24	57.8	-1.05646	-1.62173	-1.11002	2.20066
Sweden	6.10	0.956	38.2	0.74	25.0	0.72304	-0.28672	1.44527	-1.16539
Turkey	2.10	0.775	41.4	0.22	43.6	-1.15012	0.12910	-1.21223	0.74340
UK	5.60	0.946	40.3	0.57	36.0	0.48889	-0.01380	0.57647	-0.03653
US	9.60	0.951	28.8	0.67	40.8	2.36205	-1.48913	1.08753	0.45606

Note: ZEF: Standardized EF; ZHPI: Standardized HPI; ZGIP: Standardized GIP; Zgini: Standardized Gini Coefficient

Source: *EF: Global Ecological Footprint Network (2006)*

HDI: United Nations Development Programme (2007)

GIP: Global Innovation Scoreboard (2007)

Gini Coefficient: United Nations Development Programme (2007)

Appendix 3a. Report on Multi-variable Cluster analysis: Results for 4 clusters

1. Initial Cluster Centers

	Cluster			
	1	2	3	4
EF	.80	6.10	2.10	2.30
GIP	.17	.74	.22	.24
Gini	36.8	25.0	57.0	57.8
Life Expectancy	63.3	80.2	70.5	48.4
Life Satisfaction	5.4	7.7	6.3	5.7

2. Iteration History(a)

	Change in Cluster Centers			
Iteration	1	2	3	4
1	4.451	6.432	7.107	.000
2	.000	.000	.000	.000

a Convergence achieved due to no or small change in cluster centers. The maximum absolute coordinate change for any center is .000. The current iteration is 2. The minimum distance between initial centers is 21.414.

3. Cluster Membership

Case Number	Country	Cluster	Distance	Case Number	Country	Cluster	Distance
1	**Argentina**	3	1.872	14	**Japan**	2	7.302
5	**China**	3	3.724	15	**Korea, Rep**	2	2.505
3	**Brazil**	3	7.107	22	**Sweden**	2	6.432
16	**Mexico**	3	4.784	17	**New Zealand**	2	5.111
4	**Canada**	2	2.926	18	**Norway**	2	5.437
6	**Denmark**	2	6.692	24	**UK**	2	4.856
7	**Finland**	2	4.739	20	**Slovenia**	2	4.147
8	**France**	2	1.880	25	**US**	2	10.506
9	**Germany**	2	3.076	21	**South Africa**	4	.000
10	**Greece**	2	3.308	23	**Turkey**	1	4.589
11	**Hungary**	2	7.625	12	**India**	1	4.451
2	**Australia**	2	4.543	19	**Russia**	1	2.152
13	**Israel**	2	8.210				

4. Final Cluster Centers

	Cluster			
	1	2	3	4
EF	2.43	5.63	2.15	2.30
GIP	.26	.56	.22	.24
Gini	40.1	31.1	50.3	57.8
Life Expectancy	65.8	78.5	72.9	48.4
Life Satisfaction	5.0	7.0	6.6	5.7

5. Distances between Final Cluster Centers

Cluster	1	2	3	4
1		16.032	12.584	24.807
2	16.032		20.285	40.377
3	12.584	20.285		25.654
4	24.807	40.377	25.654	

6. ANOVA

	Cluster		Error		F	Sig.
	Mean Square	df	Mean Square	df		
Consumption (EF)	20.450	3	2.290	21	8.930	.001
Innovation (GIP)	.192	3	.016	21	11.838	.000
Equity (Gini)	581.231	3	25.484	21	22.807	.000
Life Expectancy	396.863	3	4.632	21	85.672	.000
Life Satisfaction	3.700	3	.434	21	8.523	.001

7. Number of Cases in each Cluster

Cluster	1	3.000
	2	17.000
	3	4.000
	4	1.000
Valid		25.000
Missing		.000

Appendix 3b. Report on Multi-variable Cluster analysis: Results for 5 clusters

1. Initial Cluster Centers

	Cluster				
	1	2	3	4	5
Consumption (Ecological Footprint)	2.30	9.60	2.10	5.80	.80
Innovation (GIP)	.24	.67	.22	.59	.17
Equity (Gini)	57.8	40.8	57.0	24.7	36.8
Life Expectancy	48.4	77.4	70.5	77.2	63.3
Life Satisfaction	5.7	7.4	6.3	8.2	5.4

2. Iteration History(a)

Iteration	Change in Cluster Centers				
	1	2	3	4	5
1	.000	4.767	5.538	3.713	4.451
2	.000	1.506	1.595	.000	.000
3	.000	1.102	.000	1.122	.000
4	.000	.000	.000	.000	.000

a Convergence achieved due to no or small change in cluster centers. The maximum absolute coordinate change for any center is .000. The current iteration is 4. The minimum distance between initial centers is 16.563.

3. Cluster Membership

Case Number	Country	Cluster	Distance	Case Number	Country	Cluster	Distance
1	**Argentina**	3	1.872	13	**Israel**	2	3.809
5	**China**	3	3.724	10	**Greece**	2	2.335
3	**Brazil**	3	7.107	8	**France**	2	3.311
16	**Mexico**	3	4.784	17	**New Zealand**	2	.635
18	**Norway**	4	2.014	2	**Australia**	2	1.439
6	**Denmark**	4	2.807	24	**UK**	2	1.000
7	**Finland**	4	2.737	4	**Canada**	2	3.677
11	**Hungary**	4	5.669	25	**US**	2	6.168
9	**Germany**	4	1.629	12	**India**	5	4.451
14	**Japan**	4	4.588	23	**Turkey**	5	4.589
15	**Korea, Rep**	4	4.986	19	**Russia**	5	2.152
20	**Slovenia**	4	2.741	21	**South Africa**	1	.000
22	**Sweden**	4	3.214				

4. Final Cluster Centers

	Cluster				
	1	2	3	4	5
Consumption (EF)	2.30	6.31	2.15	5.02	2.43
Innovation (GIP)	.24	.54	.22	.58	.26
Equity (Gini)	57.8	35.9	50.3	26.9	40.1
Life Expectancy	48.4	79.1	72.9	78.0	65.8
Life Satisfaction	5.7	7.1	6.6	6.9	5.0

5. Distances between Final Cluster Centers

Cluster	1	2	3	4	5
1		37.953	25.654	42.871	24.807
2	37.953		16.261	9.088	14.650
3	25.654	16.261		24.105	12.584
4	42.871	9.088	24.105		18.264
5	24.807	14.650	12.584	18.264	

6. ANOVA

	Cluster		Error		F	Sig.
	Mean Square	df	Mean Square	df		
Consumption (EF)	17.100	4	2.052	20	8.333	.000
Innovation (GIP)	.146	4	.017	20	8.697	.000
Equity (Gini)	520.369	4	9.869	20	52.726	.000
Life Expectancy	298.874	4	4.619	20	64.711	.000
Life Satisfaction	2.787	4	.453	20	6.146	.002

7. Number of Cases in each Cluster

Cluster	1	1.000
	2	8.000
	3	4.000
	4	9.000
	5	3.000
Valid		25.000
Missing		.000

Appendix 4. Table of Hypothetical archetypal paths of development: Extinct, Existing and Visionary Ideal

Pattern 1 – Hollow development (2.5 – 4.3 planets)	Pattern 2 – Stagnant/traditional (< 1.5 planet)	Pattern 3 – Exploring or receding (< 2.5 planets)
High levels of consumption; Lowest disparity in income/wealth distribution; Good and long lives; Satisfied with life; High innovation performance *Example: High-tech countries, i.e. Scandinavian countries, Japan, Germany*	Low levels of consumption; High disparity in income/wealth distribution; Medium long lives; Dissatisfied with life; Low innovation performance *Example: Low-tech countries, i.e. Latin American countries, India, (South Africa), Turkey, Greece*	Medium levels of consumption; Low or medium low disparity in income/wealth distribution; Medium or good long lives; Quite satisfied with life; Medium innovation performance *Example: Catch-up countries, i.e. Eastern European countries and Receding countries such as Russia*
Pattern 4 – Explosive consumptive (5 planets) The worst case existing???	Pattern 5 – Traditional egalitarian society (existing in fact but not in database; Indigenous groups lack statehood and protection)	Pattern 6 – Unstable empires (ancient civilizations) / Phase 2 of Pattern 4
Extreme high level of consumption; High disparity of income/wealth distribution; Good and long lives; Satisfied with life; High innovation performance *Example: High-tech countries, i.e. US*	Low levels of consumption; Low disparity in income/wealth distribution; Medium long lives; Satisfied with life; Low innovation performance	Extreme high levels of consumption; High disparity in income/wealth distribution; Short lives; Satisfied with life; High innovation performance
Pattern 7 – Visionary ideal (non existence on planet Earth in 21st century)	Pattern 8 – Crisis kingdoms (not in database but existent in reality, e.g. Myanmar, Zaire, Haiti)	
Sustainable level of consumption; Low disparity of income/wealth distribution; Good and long lives; Satisfied with life; High innovation performance	Low/high levels of consumption; High disparity in income/wealth distribution; Short lives; Dissatisfied with life; Low innovation performance	

Pattern 1 has two sub-clusters, in which one that have low disparity in income and wealth distribution. Examples of this sub-cluster include Scandinavian countries, Germany and Japan. The other that has medium high disparity in income and wealth distribution includes Anglo-Saxon societies and the like, i.e. UK, Australia, Israel, New Zealand, and France.